

Final Technical Support Document for HWC MACT Standards

Volume III:

Selection of MACT Standards and Technologies

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ACRONYMS

A/C	Air-to-cloth ratio; used for describing fabric filter design; defined as the fabric cloth area divided by the flue gas flow rate through the fabric filter
ACI	Activated carbon injection; activated carbon is used for both mercury and organics (including PCDD/PCDF) control
APCD	Air pollution control device
APCS	Air pollution control system
ASTM	American Society of Testing and Materials
BIF	Boilers and Industrial Furnaces
BTF	Beyond the floor
CAA	Clean Air Act Amendments
CEMS	Continuous emissions monitoring system; flue gas emissions monitoring systems that can provide continuous real-time analysis on-line; for monitoring HAPs such as PM, Hg, CO, HC, etc.
CETRED	Combustion Emissions Technical Resource Document
CK	Cement kiln
CKD	Cement kiln dust
CMS	Continuous monitoring system
CO	Carbon monoxide
CPT	Comprehensive performance test
DL	Detection limit
DOE	Department of Energy
D/O/M	Design, operating, and maintenance procedures
DRE	Destruction and removal efficiency
dscf	Dry standard cubic feet
dscm	Dry standard cubic meter
EER	Energy and Environmental Research Corporation
EPA	Environmental Protection Agency
ESP	Electrostatic precipitator
FF	Fabric filter (baghouse)
FID	Flame ionization detector
GCP	Good combustion practices
GOP	Good operating practices
g	Gram
gr	Grain (7000 grains per pound)
HAP	Hazardous air pollutant
HC	Hydrocarbons
HCl	Hydrogen chloride
Hg	Mercury
HW	Hazardous waste
HWC	Hazardous waste combustor
HWI	Hazardous waste incinerator
ITEF	International Toxicity Equivalency Factor System (for PCDD/PCDF TEQ determination)
IWS	Ionizing wet scrubber
LVM	Low volatile metals
LWAK	Lightweight aggregate kiln
MACT	Maximum achievable control technology
MB	Mass balance
MHRA	Maximum hourly rolling average
MTEC	Maximum theoretical emissions concentration

MWC	Municipal waste combustor
MWI	Medical waste incinerator
NODA	Notice of Data Availability
NSPS	New Source Performance Standard
OS	On-site captive incinerator
PCB	Polychlorinated biphenyls
PCDD/PCDF	Polychlorinated dibenzo-p-dioxins and dibenzofurans
PIC	Products of incomplete combustion
PM	Particulate matter
POHC	Principal organic hazardous constituent
ppmv	Parts per million by volume in gas
PQL	Practical Quantitation Limit
RA	Run average
RCRA	Resource Conservation and Recovery Act
SCA	Specific collection area; for ESPs, determined as the ratio of flue gas flow rate to ESP plate area
SRE	System removal efficiency; determined as one minus the ratio of the stack gas emissions to total input feedrate of a HAP
SVM	Semivolatile metals
TEQ	Toxic equivalent; for PCDD/PCDF, a measure of the normalized toxicity of the individual congener/isomers
VS	Venturi scrubber
WHB	Waste heat boiler
WS	Wet scrubber

ACRONYMS IN MACT DATA TABLES

B	Baseline, no hazardous waste was burned during the test condition.
BPM	Measurement made at the alkali bypass stack of a short kiln.
CA	Test condition average only available. Individual runs were not available in test report.
CI	Carbon injection was used during the test condition.
CMBM	Combined main and bypass stack gas measurement for short cement kilns.
Comm	Commercial incinerator.
EFS	Emissions measurement exceeds the federal standard. Data was therefore not considered for the MACT evaluation.
ICM	Incomplete PCDD/PCDF congeners and/or isomers were measured.
ILRM	Cement kiln has an operating in-line raw mill (“off” means it was not operating during test, and “on” means it was operating during source testing).
MB	Mass balance problem.
MHRA	For CO and HC, maximum hourly rolling average.
ND/T	The % of the total feed rate that is measured at the detection limit.
NHWBCK	Non hazardous waste burning cement kiln (kiln never has burned hazardous waste).
NLBHW	Source is no longer burning hazardous waste.
Nor	“Normal” condition (normal waste and operating conditions during testing).
NW	Source was burning normal waste (i.e., no spiking was conducted).
NS	Source was not spiking constituents.
NSPS	Source is subject to the cement kiln New Source Performance Standard.
OS	On-site captive incinerator.
RA	For CO and HC, the run average.
RT	Testing was for research type evaluation purposes.
S/HW	The percentage of the HW MTEC that is apparently associated with spiking.
WHB	System has waste heat boiler used for flue gas cooling.

CHAPTER 1

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is setting “Maximum Achievable Control Technology” (MACT) standards for hazardous waste combustors (HWCs): hazardous waste incinerators (HWIs), hazardous waste burning cement kilns (CKs), and hazardous waste burning lightweight aggregate kilns (LWAKs). The MACT emission standards are being developed under Title III of the 1990 Clean Air Act Amendments (CAA). MACT emissions standards are established for the following hazardous air pollutants (HAPs) from HWCs: polychlorinated dioxins and furans (PCDD/PCDF); mercury (Hg); semivolatile metals (SVM) which include cadmium (Cd) and lead (Pb); low volatile metals (LVM) which include arsenic (As), beryllium (Be), and chromium (Cr); hydrogen chloride and chlorine gas as total chlorine (HCl and Cl₂); particulate matter (PM) as a surrogate for the HAP metals of cobalt (Co), manganese (Mn), nickel (Ni), selenium (Se), and antimony (Sb); and carbon monoxide (CO) and hydrocarbons (HC) as surrogates for non-PCDD/PCDF organic HAPs.

This document provides technical support for the determination of the MACT emissions standards, including the approach and procedures used for the existing and new source MACT floors for each HAP and source category. It is the third in a series of five volumes of technical background documents that support the final HWC MACT rule. The others include:

- *Technical Support Document for HWC MACT Standards, Volume I: Description of Source Categories*, which contains process descriptions of each of the hazardous waste combustor source categories (incinerators, cement kilns, and lightweight aggregate kilns). Also included are discussions on air pollution control device design, operation, and performance characteristics of current systems, as well as state-of-the-art techniques that are applicable.
- *Technical Support Document for HWC MACT Standards, Volume II: HWC Emissions Data Base*, which contains a summary of the HWC emissions information on metal HAPs, particulate matter, HCl and Cl₂, hydrocarbons, carbon monoxide, semivolatile and volatile

organic compounds, and PCDD/PCDF. Other information contained in the data summary include company name and location, emitting process information, combustor design and operation information, APCD design and operation information, stack conditions during testing, feedstream feed rates, and emissions rates of HAPs by test condition.

- *Technical Support Document for HWC MACT Standards, Volume IV: Compliance with the HWC MACT Standards*, which contains discussions of continuous emissions monitors and operating parameter limit compliance requirements for the final rule.
- *Technical Support Document for HWC MACT Standards, Volume V: HWC Emissions Estimates and Engineering Costs*, which contains cost estimates and emissions reductions associated with the HWC MACT standards.

This work draws from EPA's HWC MACT proposed rule (61 FR 17358 (April 19, 1996)) and various Notices of Data Availability (including the January 1997 NODA at 62 FR 660 (January 7, 1997), and a May 1997 NODA at 62 FR 24212 (May 2, 1997)). It also considers stakeholder comments on the proposal and NODAs.

This document consists of the following sections:

Chapter 2 -- Describes the procedures used to determine the MACT floors for existing and new sources.

Chapters 3 through 9 contain evaluations of MACT floors for existing and new sources for each of the source categories (incinerators, cement kilns, and lightweight aggregate kilns) for the following HAPs or HAP surrogates:

Chapter 3 -- Polychlorinated dioxins and furans

Chapter 4 -- Particulate matter

Chapter 5 -- Carbon monoxide and hydrocarbons

Chapter 6 -- Aggregate Feedrate MTEC Results

Chapter 7 -- Mercury

Chapter 8 -- Semivolatile metals (Cd and Pb)

Chapter 9 -- Low volatile metals (As, Be, and Cr)

Chapter 10 -- Total chlorine (HCl and Cl₂)

Chapter 11 -- Destruction and removal efficiency

Chapter 12 discusses miscellaneous topics, including: (a) the rationale for the use of CO/HC and PM as surrogates for HAPs; (b) affect of burning hazardous waste on chlorinated product of incomplete combustion emissions from cement kilns; (c) comparison of the relative HAP contributions from waste, coal, and raw materials in industrial kilns; (d) evaluation of metal and chlorine feedrates for industrial kilns for different feedstream; (e) raw materials HAP contributions to emissions from industrial kilns; (f) impact of burning chlorine-containing hazardous waste on industrial kiln raw materials metals behavior; (g) mobile source incinerator performance; (h) MACT defining metals and chlorine feedrates for industrial kiln alternative standards compliance determination; and (i) relationship between metals and chlorine feedrate and stack gas emissions.

Chapter 13 contains an evaluation of the method precision of various stack gas emissions test methods. Chapter 14 discusses beyond-the-floor control method performance and applicability. The last chapter contains references.

The appendices contain the following background information:

Appendix A -- List of air pollution control device acronyms

Appendix B -- List of facility names and locations by three digit EPA ID Number

Appendix C -- Lists of updates and corrections to the HWC database

CHAPTER 2

MACT FLOOR EVALUATION PROCEDURES

The procedures and considerations used in the final rule for setting the HWC MACT floors are outlined in this chapter (as well as in the specific HAP MACT floor evaluation chapters in the rest of this document), including:

- General MACT Procedure
 - Development of data evaluation tables
 - Emissions data ranking
 - Consideration of data used to define and determine MACT
 - Definition of MACT
 - Aggregate Feedrate Approach
 - Determination of MACT expanded universe
 - Data screening and outlier analysis
 - Determination of MACT floor standard based on MACT definition
 - Consideration of emissions variability factor
- Miscellaneous Considerations
 - Imputation
 - Handling of detection limits and PCDD/PCDF calculations
 - Revised HWC database
 - Subcategorization for incinerators and cement kilns

Note that the final rule MACT analyses are built on proposed rule (61 FR 17358 (April 19, 1996)) and the May 1997 NODA (62 FR 24212 (May 2, 1997)) procedures and comments. Differences in the final rule analysis compared with the proposed rule and May 1997 NODA analyses are highlighted.

2.1 GENERAL MACT FLOOR PROCEDURE

The procedures used to set the final rule MACT floors involve:

- Arraying, ranking, and evaluating emissions data (as well as feedrate data for chlorine and metals for HAPs in hazardous waste) to identify the MACT control used by the average of the 12% of best performing sources.
- Determining an emissions level that the MACT control can routinely achieve in practice based on data from sources employing MACT control.

The D.C Circuit determined in *Sierra Club v. EPA*, 167 F.3d 658, 665 (D.C. Circuit, 1999) that this is a permissible means of establishing floor levels.

Note that the procedures for the standards for PCDD/PCDF, PM, and CO/HC, where emissions are not strongly related to the feedrate of specific HAPs in the hazardous waste, are generally the same as those discussed in the May 1997 NODA. Alternatively, the MACT floor procedures for Hg, SVM, LVM, and total chlorine standards, where emissions are directly related to the feedrate of the HAPs contained in the hazardous waste, involve the use of an “Aggregate Feedrate” approach for defining the feedrate component of MACT control for certain HAPs. This approach has been developed subsequent to and as an outgrowth of the proposed rule and May 1997 NODA. Details of the MACT procedures are discussed in the following subsections.

2.1.1 Development of Data Evaluation Tables

Similar to the proposed rule and May 1997 NODA, for each source category, HAP emissions and feedrate data from different facilities and test conditions are compiled from EPA’s HWC Emissions Database. The database is described in detail in the accompanying *Technical Support Document for HWC MACT Standards, Volume II: HWC Emissions Data Base*. The database contains detailed results of over 100 trial burns and compliance tests from incinerators and cement and lightweight aggregate kilns. All data considered are in terms of flue gas concentrations, corrected to 7% oxygen (O₂) and standard conditions. “Non-detects” (measurements at the analytical method detection limit) are considered at half the detection limit, as discussed in a following subsection of this chapter.

As in the May 1997 NODA and the proposed rule, for each HAP, all individual test conditions are ranked from lowest to highest by the test condition average HAP emissions concentration. When a source has emissions data for a HAP from several different tests conditions, each test condition is considered separately. That is, for each unit that has conducted a series of tests under different operating conditions, data generated under one test condition is not combined with emission data of a completely separate test condition. Each test condition is treated separately because each test condition is conducted using similar waste types and under similar facility operating conditions (such as temperature, waste feedrate, etc.). This is because it is not appropriate to pool results from widely different test conditions (for example, from a metals/chlorine test condition and an organics test condition).

MACT evaluations are conducted separately for each floor standard and for each source category. A “supersource” analysis (evaluation of a single HAP standard for all three source categories simultaneously) was not considered because, although the source categories have the similarity of burning hazardous waste, each has different characteristics and emissions profiles, making a supersource category technically inappropriate. Further subcategorizing of the three source category groups is not used. Reasons for this are discussed in detail in the subcategorization subsection of this chapter.

The data evaluation ranking tables, developed for each floor standard and source category combination, are included in Chapters 3 through 10 for each floor standard and include a summary of the pertinent considerations used in the MACT floor evaluation. The contents of the data evaluation ranking tables include (these designations are similar to those used for the proposed rule and May 1997 NODA):

- “EPA Cond ID” -- Defines the test condition identification number corresponding to the ID number used in the EPA HWC database. The facility name and location corresponding to the three digit ID code are given in Appendix A.
- “APCS” -- Identifies the air pollution control systems employed by the source. An acronym list is included in Appendix B.
- “No. Runs” -- Number of individual runs within a test condition.
- “Cond. Description” -- Brief description of the purpose of the testing.

- “APCD Temp.” -- Operating temperature of the air pollution control device (inlet flue gas temperature) (for PCDD/PCDF only).
- “Stack Temp.” -- Temperature of the flue gas at the emissions measurement location, typically in the stack (shown for PCDD/PCDF only).
- “Summary Comments” -- Summary of key characteristics of condition, including acronyms signifying a number of different considerations, including:

B	Baseline, no hazardous waste was burned during the test condition.
BPM	Measurement made at the alkali bypass stack of a short kiln.
CA	Test condition average only available. Individual runs were not available in test report.
CI	Carbon injection was used during the test condition.
CMBM	Combined main and bypass stack gas measurement for short cement kilns.
Comm	Commercial incinerator.
EFS	Emissions measurement exceeds the federal standard. Data was therefore not considered for the MACT evaluation.
ICM	Incomplete PCDD/PCDF congeners and/or isomers were measured.
ILRM	Cement kiln has an operating in-line raw mill (“off” means it was not operating during test, and “on” means it was operating during source testing).
MB	Mass balance problem.
MHRA	For CO and HC, maximum hourly rolling average.
ND/T	The % of the total feed rate that is measured at the detection limit.
NHWBCK	Non hazardous waste burning cement kiln (kiln never has burned hazardous waste).
NLBHW	Source is no longer burning hazardous waste.
Nor	“Normal” condition (normal waste and operating conditions during testing).
NW	Source was burning normal waste (i.e., no spiking was conducted).
NS	Source was not spiking constituents.
NSPS	Source is subject to the cement kiln New Source Performance Standard.
OS	On-site captive incinerator.
RA	For CO and HC, the run average.
RT	Testing was for research type evaluation purposes.
S/HW	The percentage of the HW MTEC that is apparently associated with spiking.
WHB	System has waste heat boiler used for flue gas cooling.

- “MTEC” -- For chlorine and metals, feedrate maximum theoretical emissions concentrations (MTEC), determined as the theoretical emissions concentration if all of the species fed to the device are assumed to partition directly to the stack. Provided for metals and chlorine for hazardous waste streams (including spiked streams), as well as “other” streams which include contributions from industrial kiln raw materials, supplemental fossil fuels, etc. The contribution of “spiked” streams to the hazardous waste total (“S/HW”) and contribution of non-detects to the total feed (“ND/T”) are also indicated.
- “SRE” -- For chlorine and metals, system removal efficiencies (SRE), determined as one minus the fraction of the constituent emitted (stack gas mass emissions rate) divided by the total input system rate (represented by the MTECs).
- “Stack Measur. Location” -- For cement kilns, the location of the stack measurement, i.e., main stack vs bypass stack vs combined bypass and main stack.

Additionally, note that the data tables are generally divided into separate sections as appropriate.

- For cement kilns, the tables are generally divided into three separate sections:
 - Data that are directly considered for setting the MACT floor, including data from long cement kilns (without in-line raw mills), that are currently burning hazardous waste.
 - Data from short kilns and/or those with in-line raw mills.
 - Data that are not directly considered for setting the MACT floors, including data from kilns that are no longer burning hazardous wastes, conditions with less than 3 individual runs, etc.
- For incinerators and LWAKs:
 - Data from currently burning incinerators and LWAKs using “add-on” MACT controls.
 - Data from currently burning incinerators and LWAKs not using “add-on” MACT controls.

- Data that are not directly considered for setting the MACT floors, including data from facilities that are no longer burning hazardous wastes, conditions with less than 3 runs, etc.

2.1.2 Emissions Data Ranking Procedures

In the data ranking tables, the individual test conditions are ranked by the arithmetic average of the emissions levels from each of the runs within the condition, typically three. It has been suggested by some proposed rule and May 1997 NODA commenters that conditions be ranked by other statistical parameters. For example, as was done originally in CETRED (U.S. EPA, “Combustion Emissions Technical Resource Document (CETRED)”, EPA 530-R-94-014, May 1994) as the condition average plus some factor multiplied by the standard deviation of the individual runs within the condition. However, because sources will comply with the MACT standards based on the arithmetic average of the individual test runs for the test condition and because the MACT floor evaluation procedures that are used in final rule analysis are not as sensitive to the exact condition ranking as the proposed rule or May 1997 NODA procedures, EPA has decided that it is most appropriate to use the arithmetic average of the test condition runs.

2.1.3 Consideration of Data Used to Define and Determine MACT

The HWC database contains data from a variety of different condition types, purposes, dates, etc. The following handling procedures are used, identical to that of the May 1997 NODA:

- Data from facilities no longer burning hazardous waste are not considered. Although these data may be of use to determine MACT control capabilities, it was decided not to consider these data in the MACT analysis because these facilities are no longer in the hazardous waste burning business. Due to the constantly changing waste burning universe, the universe is established based on that of February 1998. Note that subsequent to this date, the Medusa and Lafarge Alpena cement kiln facilities have stopped or have announced that they will stop burning hazardous waste.
- Based on data submissions in response to the proposed rule, data from multiple conditions and/or different dates are now available from many facilities (in particular, cement and lightweight aggregate kilns). Generally, data from all of the test dates are considered in evaluation of the capabilities of MACT control. Note that for national emissions estimates, risk assessment, and economic evaluations, only most-recent data are used, as discussed in

Technical Support Document for HWC MACT Standards, Volume V, Economic Evaluation.

- Data obtained under non-trial burn type conditions (such as those conducted with “normal” wastes or those under research type conditions) are not used to determine or define MACT. Such data are included in the MACT ranking tables to further determine and assess the capabilities of MACT. “Normal” conditions include those where hazardous waste was burned, but waste spiking was not conducted and/or operations were not under non-typical conditions (such as high temperature, low temperature, etc. used in compliance type testing for the setting of operating limits). The exception, as discussed in Chapter 7 in more detail, is mercury emissions data from the industrial kilns, and some incinerator metals data, which are from trial burn tests where these metals were not spiked. This data obtained under trial burn conditions is used for evaluating the MACT floors even though metals were not spiked during the testing.
- “Baseline” conditions conducted without hazardous waste (baseline fossil fuel only) are included in the ranking tables. They are used, among other data, to determine MACT for PCDD/PCDF for cement kilns. For all other HAPs though, they are not used to define MACT. Instead, they are used as a measure of the effect of hazardous waste on emissions (note that these types of conditions are generally available for cement kilns only).
- Almost all of the test conditions are composed of 3 individual runs (in a few cases 4 and more). However, in some cases, the condition was based on only 1 or 2 runs. Commenters to the proposed rule and the May 1997 NODA suggested that these conditions should not be used for the MACT evaluations (in particular, because they cannot be used properly for statistical evaluations). For the final rule, these conditions are considered for evaluating MACT capabilities, but not used for defining MACT or determining MACT floors which are sensitive to individual test conditions. Because statistical procedures for defining MACT floors are no longer used, there are no conflicts in this regard. Note also that for a couple of conditions, only condition averages are available (no individual run data are given in the emissions test report). These conditions are considered for the MACT analysis because test condition averages are used in the MACT evaluation.

2.1.4 Definition of MACT

PM, CO/HC, and PCDD/PCDF

For the PM, CO/HC, and PCDD/PCDF floor emissions standards, MACT is generally defined in a manner similar to that for the May 1997 NODA -- based on an “Engineering Information and Principles” (EIP) evaluation of the control methods used by the best performing “MACT pool” sources, as determined from a ranking of stack gas emission concentration measurements.

Based on the CAA requirements, the MACT pool is to consist of the average of the best performing 12% of sources (i.e., best 6% of sources) for existing source floor evaluations for source categories with greater than 30 sources (incinerators and cement kilns). Alternatively, for categories with less than 30 sources (LWAKs), MACT is based on the performance of controls used by the median of the best performing 5 sources in the category (i.e., best 3 sources). For new sources, MACT is based on the best controlled single source.

Again, note that “best performing” is based on sources with the lowest test condition average stack gas emissions concentrations and not based on total mass emissions or system removal efficiency as has been proposed by some commenters. Reasons for this selection are discussed in the final rule preamble and Response to Comments Document.

As in the May 1997 NODA and proposed rule, the total number of emitting sources for which the 6% (or top 3) are based is the number of different emitting sources for which emissions data are available, counting individual combustion unit emitting processes. For example, different kilns on the same site are considered as separate units. The total is not based on the number of different conditions. For example, if an emitting source had measured a particular HAP during multiple test conditions, the source would be considered only once when determining the total number of different emitting sources.

Additionally, as in the May 1997 NODA and the proposed rule, when determining the MACT pool, conditions that define the MACT pool must be from different sources. If necessary, next-in-line sources are selected to obtain the required number of different sources for the MACT pool. For example, if the MACT pool is determined to contain 3 sources, and 1 source had the best performing 3 conditions, the MACT pool would include only 1 condition from that source, and the next best performing conditions from different sources would be included in the MACT pool until the required number of different sources is reached.

Also, APCD characteristics were used to define the MACT control in the proposed rule for PM APCDs, in particular, air-to-cloth ratio (A/C) for FFs and specific collection area (SCA) for ESPs. However, for a variety of reasons discussed in the PM, SVM, and LVM chapters of this document, they are not used in the May 1997 NODA reevaluation, and continue not to be used in the final rule analysis. (Note that, although not directly used in the final rule analysis to define MACT, FF and ESP APCD defining characteristics are included in the data ranking tables for LWAKs and CKs. Values reported by industry groups are compared with those documented by EPA.)

Chlorine, Mercury, Semivolatile Metals, and Low Volatile Metals

For the HAPs of total chlorine and metals (including mercury, SVM, and LVM), MACT involves feedrate control, and in some cases “add-on” air pollution control technology (such as PM control devices for SVM and LVM, wet scrubbing for chlorine, etc.). The MACT-defining feedrate level is identified using the Aggregate Feedrate approach, discussed in the next subsection. As appropriate, the add-on control technology is selected based generally on an “Engineering Information and Principles” analysis of the best performing sources.

Similar to the May 1997 NODA approach, add-on MACT for SVM and LVM is defined as that which is determined for PM, because PM and SVM/LVM are controlled by the same type of add-on APCDs.

Aggregate Feedrate Approach

For the chlorine and metal HAPs, the feedrate of the HAP in the hazardous waste (and any other feedstreams such as raw materials for industrial kilns) has a direct relationship to the stack gas emissions level. See Chapter 12. Note that as discussed in Chapter 12, the feedrate/emissions relationship is fairly proportional over a wide range of feedrates for Hg, SVM, LVM, and chlorine.

Also note that commenters argue that feedrate should not be considered in setting MACT floors because: (1) feedrate is not a presently used control strategy (instead, it is used as a means of complying with RCRA emissions standards); (2) the use of feedrate control is not in the spirit of Maximum Achievable Control Technology since there is no add-on equipment or system removal efficiencies associated with its use; and (3) there is no relationship between feedrate and emissions levels as supported by an analysis of the feedrate and emissions data. EPA does not agree. Feedrate control continues to be considered and used as an appropriate control method for defining

and determining the MACT floors (as discussed further in the final rule preamble and response to comment document) for reasons including:

- Feedrate has a clear and direct impact on metals and chlorine emissions, as discussed in Chapter 12.
- Feedrate is a viable control method well within the methods intended to be considered under Title III of the CAA. See CAA Section 112(d)(2)(A) listing “process changes” and “substitution of materials” as types of potential MACT controls.
- Feedrate is currently being used as a control means to meet BIF hazardous waste and incinerator RCRA combustor regulations for chlorine and metals.
- The MACT floor control defining feedrate MTECs are based on facilities burning metals/chlorine containing wastes (i.e., they are not based on facilities burning wastes which do not contain metals/chlorine -- this would result in unreasonable floor feedrate and corresponding floor emissions levels).
- Metals/chlorine standards based on feedrate control will promote the use of waste minimization and source reduction to limit the generation of metals/chlorine containing wastes.
- In future practice, it is projected that wastes with higher metals/chlorine levels than the MACT control defining levels will continue to be combusted in systems using high efficiency air pollution control methods (such as state-of-the-art mercury control methods, wet scrubbers, and particulate/metal control devices).

For the proposed rule, MACT-defining feedrate limits for each of the metal and chlorine HAPs were set based on those feedrates used by the best performing, lowest stack gas concentration emissions sources (in particular, for new sources the single best performing source, and for existing sources the best 6% of sources). Many commenters to the proposed rule objected to this methodology because: (1) it produced unreasonably low MACT feedrate limits based on best performing sources that did not (for whatever reasons) feed metals- or chlorine-containing wastes; (2) it was inconsistent in that it produced different APCS MACT control definitions for similarly controlled HAPs such as SVM, LVM, and PM (which are all controlled through good PM control); (3) MACT was sometimes based on poor add-on APCDs when performance was due solely to low feedrate (this may not be consistent with the intent of MACT); (4) it “unfairly”

produced MACT-defining feedrate limits that were different for the 3 different source categories; and (5) it produced standards that were not simultaneously achievable.

We agree with many of the commenters' concerns, and repropose a revised methodology in the May 1997 NODA which avoided setting a direct MACT-defining feedrate. Instead, facilities with "non-MACT-like" feedrates were screened out indirectly through a visual outlier breakpoint analysis of the emissions data from those using MACT add-on controls. However, this approach has also been abandoned for a variety of reasons:

- It does not quantitatively define a "MACT-like" feedrate, i.e., feedrate reflecting performance of the best controlled sources.
- The proposed breakpoint outlier analysis procedure is potentially flawed (or at least susceptible to a claim of subjectivity):
 - Although loosely based on statistical outlier procedures, it is not repeatable and not scientifically rigorous; and
 - It does not provide specific reasons why a test condition is an outlier and not MACT-like.
- It again does not ensure adequate simultaneous achievability of the multiple HAP standards that are controlled solely or in part by the same control technique -- feedrate control.

For the final rule, an Aggregate Feedrate approach is used for defining feedrate MTEC limits which are a component of MACT floor control for metal and chlorine HAPs. The Aggregate Feedrate approach is appropriate because it identifies the feedrate characteristics of actual waste streams from sources using the best feedrate control in the aggregate -- i.e., for all of the HAP metals and chlorine, rather than for each metal and chlorine individually, thus ensuring simultaneous achievability. Put another way, floor control is not premised on burning a hypothetical hazardous waste which does not actually exist -- where a hypothetical hazardous waste would unrealistically reflect the lowest (or average of the lowest 12%) HAP metal and chlorine levels from many different hazardous wastes.

Specifically, the Aggregate Feedrate approach is used to identify those hazardous wastes with the lowest "aggregate" concentrations of chlorine and metals -- i.e., the "cleanest" different

hazardous waste streams resulting from the use of best performing feedrate controls. The Aggregate Feedrate approach involves identifying test conditions where:

- Hazardous waste feedrate MTECs are available for all four feedrate-related HAPS (mercury, SVM, LVM, and chlorine).
- Conditions reflect use of the MACT floor add-on control technologies for the four HAPs. In particular, incinerators must use wet scrubbers for chlorine control, use FF, IWS, or ESP, and meet the MACT floor PM level of 0.015 gr/dscf. Cement kilns must meet the PM MACT floor equivalent emissions level of 0.03 gr/dscf, and LWAKs must meet the PM MACT floor of 0.025 gr/dscf.

This subset of candidate MACT feedrate MTEC-defining test conditions is then ranked based on a determination of the overall aggregate HAP MTEC ranking as:

- Rank each HAP -- The individual HAP MTECs from the different test conditions are separately ranked from lowest to highest, and assigned a ranking of 1 to N, where N is the number of different candidate MACT-like test conditions as defined above.
- Composite HAP ranking summation -- For each test condition, the individual MTEC rankings for each of the HAPs is summed to determine a composite ranking. This total sum is used to provide an overall assessment of the level of feedrate control for each composite waste stream. Streams with lower composite rankings are better performing, relative to feedrate control, in the aggregate (and have “cleaner” wastes) than those with higher composite rankings.

This ranking is done separately for each of the three combustor source categories.

We considered whether to assign each of the HAPs a relative weight based on their potential risk (e.g., the Hg ranking would be given more importance than the LVM ranking). However, this is not done because it is not clear how HAPs can be quantitatively ranked considering both carcinogenic and non-carcinogenic risks, and the approach is potentially at odds with a technology based regulatory regime.

Test conditions from the best-ranked 6% (or best 3) -- equivalent to the average of the top 12% (or best 5) -- are used to make up the pool to define the MACT feedrate MTECs. The highest MTECs used by the best-ranked feedrate MTEC MACT pool sources are used to define MACT

feedrate control. MACT control is then defined as a combination of an add-on control technology (as appropriate) and the feedrate MTEC as identified in the Aggregate Feedrate approach.

As discussed in the following subsection, the MACT floor emissions levels are then identified based on the highest observed test condition which is using MACT add-on technology if appropriate, with a feedrate MTEC no greater than the MACT feedrate level based on the Aggregate Feedrate approach.

Note that for LWAKs (for which there are less than 30 sources in the source category), MACT feedrate control is based on the MTECs from the 3 top-ranked kilns. For cement kilns and incinerators, for which there are more than 30 sources in the source category, MACT is to be strictly based on the best performing 6% of sources. As discussed in Chapter 6, the set of test conditions for which we have MTECs for Hg, SVM, LVM, and total chlorine (so that the Aggregate Feedrate approach can be applied) is somewhat limited, and include test conditions from only 9 incinerators and 10 cement kilns. Based on strict application of the top 6% to the test conditions from these 9 or 10 sources, existing source MACT MTECs for these source categories would be based on the single best test condition (i.e., the test condition with the lowest composite ranking). This results from having complete MTECs on few test conditions for relatively large source categories. Defining MACT feedrate control for existing sources based on a single source (identical to that required for new sources) is clearly not the intent of the CAA. Thus, similar to LWAKs, MACT for existing sources for incinerators and cement kilns is based on the performance top 3 sources.

To identify the floor emission level, we considered all test conditions from sources using the add-on technology, if appropriate, with a feedrate MTEC no greater than the MACT feedrate MTEC. For this purpose, we considered all test conditions with a feedrate MTEC no greater than the MACT-defining feedrate MTEC even if we did not have complete MTEC data for the test condition for Hg, SVM, LVM, and total chlorine. This is because test conditions with incomplete MTEC data nonetheless identify emissions levels that are achievable when using the MACT feedrate MTEC (and the add-on control device, if appropriate).

2.1.5 Determination of MACT Expanded Universe

Similar to the proposed rule and the May 1997 NODA, we identify all test conditions in the entire source category which are using MACT (or equivalent) control techniques. This expanded set, containing the MACT best performing sources as well as potentially other conditions from sources that use MACT, is referred to as the MACT “Expanded Universe” (MACT EU) or

“Expanded MACT Pool”. The Agency is using this approach to best ascertain the performance MACT control can achieve in practice, considering in particular variability inherent even in properly designed and operated systems.

2.1.6 Data Screening and Outlier Analysis

For the final rule, data screening and outlier analysis includes removing test conditions (or individual runs) from consideration where:

- Flue gas measurements were reported as “non-detect” at high detection levels. In these cases, the emissions level may be significantly less than the detection limit. What constitutes “high” is determined in comparison with other measurements and the detection limit that is achievable considering typical sampling time and analytical limitations.
- Flue gas sampling or analytical testing problems occurred (e.g., high blank, poor recoveries, broken probes, non-isokinetic sampling, and other QA/QC problems).
- Emissions levels for at least one run of the condition were higher than the current RCRA standard (e.g., conditions with individual run PM measurements higher than 0.08 gr/dscf), indicating unoptimized performance.
- Mass balances (or SREs) were suspect and not consistent with that expected based on performance of similar type sources, indicating likely errors in feedrate or stack gas measurements.

Additionally, outliers are clearly identified based on “engineering information and principles” considerations. This involves detailed technical analysis and discussion of the individual test conditions which are not used to set MACT (contained in the following individual MACT analysis chapters).

As in the proposed rule and May 1997 NODA, statistical methods are not used to remove conditions from consideration (either individual data point outliers within a test condition, or test condition outliers within the MACT EU group of test conditions). Statistical methods for identifying population outliers have been developed, such as the Dixon and Rousseeuw tests for individual run within-test condition outliers and the Rosner test for multiple test condition population outliers. However, the final rule analysis continues not to use statistical methods for screening out individual runs within a test condition because:

- Generally, statistical methods are not effective on test condition data sets containing 3 or fewer individual test runs (which includes most of the data in the data base).
- If no specific technical explanation could be identified, it was assumed that the individual run data were valid. Individual run variation can be due to real differences in waste and raw materials compositions, air pollution control and combustion system differences, test method variations, etc.
- The methodology used to identify MACT floor emissions levels for the final rule is relatively insensitive to individual run (or condition) outliers, as seen in Chapters 3 through 9.
- Commenters who suggested the use of statistical outlier tests could identify very few actual individual run outliers.
- All test conditions (and all associated runs) which are used in the MACT analysis meet current RCRA requirements and associated quality assurance and quality control requirements.

For the May 1997 NODA analysis, MACT EU population test condition outliers were determined using a visual screening analysis based on the overall shape and trend of the data in the MACT EU. May 1997 NODA commenters objected to the use of this procedure for a variety of reasons including: (1) it is subjective; (2) although loosely based on statistical outlier procedures, it is not repeatable nor scientifically rigorous; and (3) it does not provide specific reasons why a test condition is an outlier and not MACT-like. EPA generally agrees with these criticisms. For these reasons, therefore, the visual outlier screening method is not used in the final rule analysis.

EPA considered a more rigorous statistically-based Rosner outlier analysis technique for identifying multiple condition outliers within a given MACT EU. However, this method is not used for the final rule analysis for a variety of reasons: (1) the use of the Aggregate Feedrate approach for directly considering the effect of feedrate; (2) difficulty in determining the appropriate data distribution; (3) the sensitivity of the outlier analysis technique to various assumptions; and (4) other reasons discussed above.

2.1.7 Determination of MACT Floor Emissions Levels

The MACT EU as identified above is generally used to determine the MACT floor emissions level for each source category. The MACT floor level is the emissions level that sources in the MACT EU are able to achieve on a day-to-day basis. The floor level is identified as the highest MACT EU non-outlier condition (after data screening and outlier analysis) and engineering information and principles considerations, as in the May 1997 NODA. The “statistical emissions variability factor” analysis procedure used for the proposed rule is not used in the final rule, as discussed below.

2.1.8 Considerations for Not Using Statistical Variability Factor Procedure

General

A statistical variability analysis was used for the proposed rule to determine MACT floor emissions levels. This statistical variability analysis involved: (1) determining all conditions that are using MACT control; (2) calculating the log-mean of the individual runs for the highest emitting test condition average that is using MACT control to determine the “design” level; (3) statistically evaluating the within condition emissions variability of the MACT EU sources; and (4) calculating the MACT floor emissions level based on the design level and typical variability factor (determined as the level that could be expected to be met by the MACT EU sources 99% of the time). This procedure was designed to account for emissions variability due to:

- Within-facility variations due to differences in operating conditions, including:
 - Equipment operational parameters (incinerator and APCD operating temperatures, pressure, flow rates, etc.)
 - Equipment conditions (such as FF bag conditions, cake buildup, etc.)
 - HAP feedrates
- Measurement test method precision.

However, despite commenter arguments for the need of the statistical variability factor approach to set MACT floors (as used in the proposed rule) to account for this within-facility and test method emissions variability, this approach is not appropriate. Instead, as mentioned above,

the final rule MACT floors are based on the highest MACT EU non-outlier conditions (after data screening and outlier analysis) and engineering information and principles considerations, as in the May 1997 NODA. The resulting MACT floors are reasonably achievable and representative of the demonstrated performance using MACT floor controls (i.e., the floors adequately account for emissions variability due to both within-test condition variability and method imprecision). This is because:

- The MACT EU test conditions generally represent the full range (in fact sometimes beyond the range) of reasonably achievable levels; and
- The variability associated with combustor operations, emissions control device operations, and test methods is represented in the spread of condition averages (i.e., sources with emissions levels at the tail ends of the distribution are considered as upper and lower achievability limits).

More specifically, emissions variability is accounted for due to the following characteristics of the MACT EU data sets:

- Trial Burn Data -- Emissions data are from worst case trial burn conditions where:
 - The combustion system is stressed by operation under worst case conditions (such as difficult to burn wastes, high/low temperatures, worst case APCD operating conditions such as ESP power input, etc.).
 - Metals and chlorine spiking was conducted in most cases. This involved the intentional addition of metals and chlorine to the system to set maximum feedrate limits. Under normal operational conditions, metals and chlorine feedrates are typically much lower than the potentially inflated trial burn feedrate and emissions levels.

The trial burn emissions are thus at the upper end of system performance (i.e., compared with the lower emissions levels that are projected to be achieved under normal operational practices).

- Wide Range of Different Types of Sources -- The MACT EUs typically contain data from a wide variety of different sources within each HAP and source category combination, thus capturing the potential range in emissions due to differences in equipment operations,

design, waste type, etc. (as discussed in the specific HAP/source category discussions in the following Chapters of this document).

Note that the HWC database contains trial burn emissions reports from the majority of hazardous waste burning facilities. For incinerators, trial burn test data are available for almost all of the active commercial incinerators and over one-half of all of the on-site incinerators. For cement kilns and lightweight aggregate kilns, the database contains multiple conditions from every hazardous waste burning kiln in the entire universe as well as data from many kilns that are no longer burning wastes (it does not include data from a couple of “sister” kilns which were not required to be tested).

- Test Condition Averages Capturing Process Variability -- The MACT EUs generally contain data from many different test conditions from sources using MACT control (in some cases multiple conditions from the same source). Each test condition consists of typically three or more individual test runs. Each test run consists of a three hour integrated average. Thus, there is a tremendous amount of process variability built into each of the test conditions.
- Individual Runs Less Than Floor -- Typically the vast majority of the MACT EU (and entire universe) individual test run emissions are lower than the MACT floor -- thus further indicating the built-in allowance for within test condition variability by selecting the floor as the highest non-outlier test condition average. Also, compliance with the MACT standards is on a three run average basis, which damps potential variability within runs, and reduces the chances for non-compliance to be based on normal process variability.
- Wide Range of Emissions Levels -- The MACT EUs typically span a wide range of emissions levels (for example, an order of magnitude or more between the high and low ends). This would indicate that the floor, which is based on the highest non-outlier MACT EU source, is capturing and accounting for the possible range of variability.
- Achievability by Entire Universe -- The entire universe of data (containing those sources which are not determined to be using the MACT control) is also used as a secondary indicator of the achievability of the MACT floor. In many cases, a large percentage of the entire universe can meet the floors (i.e., even without MACT controls), thus further indicating that the floor represents the performance achievable by the best controlled sources in practice.

- MACT Control Based on Feedrate Control -- For standards which are based on feedrate control, consideration for variability is only needed to account for potential test method imprecision. This is because feedrate control can be very well defined and practiced. Note that HAP feedrates may vary as a function of raw materials. However, the provision for alternative standards for kilns is designed to take into account emission level variations due to feedrates of raw materials that cannot be adequately controlled.
- Engineering Judgment -- The MACT floors are consistent with the reasonably achievable range of SREs and feedrates, based on both trial burn data and engineering judgment. Alternately, the resulting MACT floor emissions levels using the statistical variability analysis for many HAPs were not consistent with engineering judgment, and some were even higher than current standards allow.

Additionally, note that:

- Floors using the final rule approach (where the floor is based on the highest non-outlier MACT EU source) are higher than those that would result from approaches recommended by some commenters based on alternative interpretations of the CAA.
- Precedence or guidance from OAQPS on other MACT rules for not adding a statistically-derived emissions variability factor when sufficient emissions test data are available (but instead basing the floors on an engineering judgment type approach as used in this rule).

HAP-Specific Considerations

Additionally, consideration of specific aspects of the data sets, outlier screening, and MACT procedures used for each HAP and source category combination further support not using the statistical variability factor analysis approach, as discussed in further detail in Chapters 3 through 10:

- PM
 - Incinerators -- The floor is based on the demonstrated performance of well designed, operated, and maintained FF, ESP, and IWSs. The MACT EU data set of test conditions meeting the floor level of 0.015 gr/dscf include those from many different incinerator types, ash levels, entrainment rates, etc. The level is consistent with PM standards that have been set for other waste combustion sources (e.g.,

municipal and medical waste combustors). Many systems operating under potentially difficult PM control situations (such as those with rotary kilns burning high ash-containing wastes) are consistently achieving this level.

- Cement Kilns -- The floor is based on well designed and operated ESP and FFs, and is taken from the Portland Cement Kiln NSPS. This level is being readily achieved by all types of CKs.
- LWAKs -- The floor is based on the highest emitting hazardous waste burning LWAK test condition average in the entire universe. It is consistent with an engineering judgment assessment of the performance expected with a well-designed and operated FF.
- PCDD/PCDF
 - Incinerators -- For those sources not using waste heat boilers, the floor emissions level of 0.4 ng TEQ/dscm and dry PM air pollution control device temperature of less than 400°F or 0.2 ng TEQ/dscm is based on the highest emitting incinerator that is using rapid quench flue gas temperature control and dry PM APCD temperature less than 400°F. Over 90% of these conditions are meeting a level of less than 0.2 ng TEQ/dscm. For incinerators with waste heat boilers, the floor is based on the highest observed individual test run due to the limited data set.
 - Cement Kilns -- Similar to incinerators, the majority of the data indicate that, by using MACT control (APCD temperature control), a level of 0.2 ng TEQ/dscm is consistently achieved. The floor emissions level is 0.4 ng TEQ/dscm and PM APCD temperature of less than 400°F, or 0.2 ng TEQ/dscm. This reflects the performance of kilns using rapid quenching of flue gases to 400°F at the inlet of PM APCDs.
 - LWAKs -- Due to the limited data set, the floor is based on the highest observed individual test run using MACT control of dry PM APCD temperature less than 400°F.
- Hg

- MACT control is control of the feedrate of mercury in the hazardous waste (i.e., other operating factors have a lesser effect on Hg emissions variability). MACT control for incinerators also includes wet scrubbing. Variability due to mercury feedrate is directly considered in the emissions test data. For the three source categories, the MACT floor is based on some of the highest normal waste condition emissions data. Thus the floor accounts for some degree of variability in normal waste mercury levels. Also, the potential variability of mercury levels in kiln raw materials can be addressed by the provision for alternative standards for industrial kilns (as discussed in the companion *Technical Support Document Volume IV: Compliance With MACT Standards*).
- SVM/LVM
 - SVM/LVM are controlled by achieving the PM standard and controlling hazardous waste metal feedrates. Emissions variability for the PM standards has been accounted for as discussed above. Also, as discussed above for mercury, variation due to SVM/LVM feedrate can be well controlled.
- Chlorine
 - Incinerators -- Variability is directly accounted for because the floor level is consistent with using the MACT control of both well designed and operated wet scrubbers (as indicated by chlorine SREs of greater than 99%) and MACT-like chlorine feedrates.
 - Cement Kilns -- The floor is based on one of the highest emitting sources in the entire universe. The MACT EU spans a wide range of emissions levels (less than 1 ppmv to 140 ppmv) and SREs (90 to 99+%). The universe also includes multiple test conditions from over 40 cement kilns, representing a very wide range of potential variables that could effect chlorine emissions. These variables include raw materials alkalinity, APCD type, APCD temperature, CKD recycle rates, etc.
 - LWAKs -- The floor is based on one of the highest emitting sources in the entire universe.
- CO/HC

- Incinerators -- The floor is based on emissions data from many sources consisting of a wide range of operating parameters and test conditions, designs, wastes, etc. Also, CO/HC limits from trial burn tests are set as maximum operating limits. Sources must generally comply with these demonstrated limits on a continuous ongoing basis. Consequently, these limits are reasonably achievable.
- Cement Kilns -- Main stack floors are based on current BIF rule standards.
- LWAKs -- As with CKs, floors are based on current BIF rule standards.

Test Method Precision

An analysis of test method precision from available data is shown in Table 2-1 and discussed in detail in Chapter 13. Precision is generally very good, being less than 30% in almost all cases, further supporting the elimination of the use of a statistical emissions variability factor. Note that for Cr, the method precision is over 30%. However, method precision is likely unreasonably high due to the use of limited data of poor quality (there is no technical reason that Cr precision should be much different from that of other LVM or SVMs).

2.2 MISCELLANEOUS CONSIDERATIONS

2.2.1 Imputation

For the proposed rule and May 1997 NODA, imputation (filling in a value for an unmeasured constituent) was sometimes used in situations where a HAP was comprised of a group of individual constituents. MACT analysis groupings include:

- Low volatile metals, comprised of beryllium, arsenic, and chromium (note that antimony was included in the proposed rule; however, in the May 1997 NODA and final rule, antimony is not part of LVM);
- Semivolatile metals, comprised of cadmium and lead; and
- Total chlorine, comprised of HCl and Cl₂.

For the proposed rule, an imputation procedure was used which included: (1) determining an average ranking of the measured components of the group in relation to other facility

measurements; (2) ranking all available data for the missing unmeasured component from other facility measurements; and (3) using imputation of the missing component at the same percentile as that of the measured data in step 1. Comments to the proposed rule note that this imputation procedure will not preserve the distribution of the data because it will skew the “tails”, making the measured data that were low even lower, and data that were high even higher (i.e., low emissions data are added to substituted data with correspondingly low emissions and conversely high emissions data are associated with substituted data that is also high). This imputation methodology is valid if there is a strong correlation between emissions of the various metals within a group (i.e., if a single control technology was dominant and affected all metals equally). However, in addition to the particulate control technology (which affects all metals in a group equally), emissions are strongly influenced by metals feedrates (which vary independently from metal to metal).

Thus, for the May 1997 NODA MACT floor reevaluation, an imputation procedure known as the “hot deck” method was used. It is a random substitution method. For missing values, a level is randomly selected from a pool consisting of all measured values (by source category). This procedure will maintain the universe distribution. A slightly modified hot deck procedure was used to fill in data holes. Imputation was used only to fill essentially complete data sets, consisting of those data sets where data were complete for the major contributors and only missing for those species expected to be relatively minor contributors:

- For total chlorine, Cl_2 is considered a minor contributor because it is typically a small fraction compared to HCl. Cl_2 is usually less than 20% of the total chlorine.
- For SVM, cadmium is considered a minor contributor compared to lead. Cadmium is usually less than 15% of the SVM total.
- For LVM, beryllium is considered a minor contributor compared to chromium and arsenic. Beryllium is usually less than 5% of the LVM total.

For example, if for a given condition cadmium was measured but lead was not, lead would not be imputed. This test condition data would not be considered for the SVM MACT analysis.

For the final rule, only complete data sets are used for the MACT floor analysis because (based on further comments to the May 1997 NODA):

- A sufficient number of complete data sets are available for setting the MACT floor standards for each of the HAP group and source category combinations.

- The MACT floor standards should not be based on “manufactured” emissions data which contain imputed data. If emissions limits are set based on imputed data, it is possible that the limit may not be routinely achievable in practice.
- As mentioned above, on average we can identify individual HAPs that are minor contributors compared with others in the group. However, there are cases where typically minor HAPs can be an important contributor to the HAP group.

Note that the imputation procedure used for the final rule economic and risk evaluations is sufficient and preferred compared with the alternatives (such as not using imputation at all). As discussed in further detail in the *Technical Support Document for HWC MACT Standards, Volume V: Emissions Estimates and Engineering Costs*, the imputation procedure involves an engineering judgment-based semirandom “hot deck” method to fill data holes for all incomplete test conditions in the data base. This procedure was used to complete grouped HAPs, and to fill in completely missing HAP emissions. However, because of the uncertainties and well-known limitations of any imputation strategy, imputed data are not used to set the MACT floors.

2.2.2 Handling of Detection Limits and Calculation of PCDD/PCDF

For the proposed rule, data measured at the detection limit (reported as non-detect) were assumed to be present at the full detection limit. For the final rule analysis, as was done in the May 1997 NODA, one-half detection limits are used when possible. Since non-detects are actually at an unknown amount below the detection limit, assuming they are present at one-half the detection limit is likely to be closer to the true value than assuming they are present at the full detection limit. This approach is consistent with data analysis techniques used in other EPA environmental programs such as the evaluation of groundwater monitoring data. Also, compared with the alternative of using zero for non-detects, the use of one-half of the detection limit acts to produce conservative results that provide increased confidence in the development and assessment of achievable standards.

Note that for PCDD/PCDF TEQ calculations, when complete congener/isomer data are available, TEQs are also determined assuming one-half detection limits for individual non-detect congener measurements (those reported at the detection limit). Again, this procedure is technically conservative with respect to ensuring achievability in that EPA Method 23 for PCDD/PCDF specifies the use of zero for non-detect measurements (i.e., use of one-half non-detects would potentially make the MACT floor standard higher than the use of zero). Further, it was considered

in the proposed rule to assume that non-detects were present at the full detection limit. But, as shown in Table 2-2 (which compares PCDD/PCDF levels assuming full and one-half detects for non-detect congeners), there is no significant difference in the PCDD/PCDF TEQ levels and MACT floor levels. Therefore, individual non-detect PCDD/PCDF congeners are assumed present at one-half the detection limit.

Also, in situations where only a TEQ level is reported in the emissions test documentation the value is used, even though it is likely calculated using zero for non-detect measurements. Additionally, note that the toxic equivalent factors (TEF) used to calculate the TEQ are from the ITEF set, as was done in the proposed rule and the May 1997 NODA.

2.2.4 HWC Emissions Database

A “fourth generation” database is used for the final rule MACT evaluations. The initially developed database supporting the proposed rule was updated based on public comments, including many new trial burn and CoC test report data submissions. The resulting second generation database was then rereleased in the January 1997 NODA for additional public comment. Based on public comments received in response to January 1997 NODA (again including additional data submittals), the database was once again updated. Note that specific January 1997 NODA comments with supporting documentation were directly addressed. When differences were considered minor (less than 10% change in the parameter), no changes were made. Additionally, spot checks were made between the Agency’s database and that of the Cement Kiln Recycling Coalition. A comprehensive line-by-line check was not made. It was concluded based on these spot checks that the database, as updated and revised, is sufficiently accurate to determine MACT floors based on the engineering and data analysis methods used to set the final rule MACT floors. The resulting “third” generation database was used as a basis for the reevaluation of the MACT standards for the May 1997 NODA. Further database comments and trial burn reports have been added since the May 1997 NODA reevaluation, resulting in the “fourth generation” database which is used for the final rule MACT analysis.

2.2.4 Subcategorization

Incinerators Based on Class and Size

Commenters have proposed the subdivision of incinerators based on: (1) small vs large (where the Agency defined small as those combustors with gas flow rates less than 20,000 actual cubic feet per minute); (2) commercial vs on-site; and (3) small on-site vs large on-site and

commercial sources. The comments are that small on-site incinerators should have less stringent standards because it is less cost-effective for them to meet standards compared with the larger sources (smaller facilities achieve less of a reduction of HAP emissions per dollar spent on emissions control than do larger facilities). However, there is no basis for the subcategorization of incinerators by class (e.g., commercial vs on-site) or size (e.g., large vs small) when determining the MACT floors due to the following considerations (which are also discussed in detail in the response to comments document):

- There are no technical differences in incinerator system equipment types, operations, uncontrolled HAP or HAP-surrogate emissions profiles, etc. between on-site and commercial incinerators or incinerators of different sizes.
- The origin of the HAP emissions from both on-site and commercial incinerator types is identical -- the hazardous waste being treated.
- The HAP emissions profiles are similar between the currently operating on-site and commercial incinerators.
- There are a number of currently operating on-site and commercial incinerators of different sizes that are using the MACT floor control methods (i.e., MACT controls are not being used only by one of the categories).
- The final rule MACT standards (HAP and HAP surrogates) are simultaneously achievable by all incinerators. All MACT control methods are applicable to all different incinerator types. There are no technical limitations for using MACT control schemes on all incinerators, regardless of size or class.
- If separate standards were to be developed for on-site or small incinerators, the resulting floor standards would be either similar or more stringent than those for the final rule using no incinerator subcategorization. This result would be contrary to the commenters' suggestion that on-site incinerators should have more lenient standards.
- MACT floors are not based on risk. Rather, they are based on control techniques used by currently operating incinerator systems.
- There are many on-site incinerators that are comparable in size to commercial incinerators.

- Selected beyond-the-floor standards have been determined to be cost-effective for all types and sizes of incinerators. With the exception of a few special cases, such as mixed waste incinerators, technologies and costs used to control HAP emissions are identical for on-site and commercial incinerators.
- Potentially low risk on-site incinerators which burn relatively “clean” wastes (referred to by the commenters as warranting more relaxed standards) may be: (1) exempt based on classification under the new comparable fuels exemption; or (2) receive waivers from the metals, chlorine, or PM emissions testing and operating requirements other than feedrate limits based on de minimis waste metals or chlorine levels. Additionally, even if they do not receive these exemptions, it will be easier for these facilities to meet the MACT floor standards since they are low HAP emitting facilities.
- Small incinerators are often one of several point sources at large industrial sites, and the cumulative risk at these sites may be equivalent to or greater than the risk from an isolated large incinerator.
- Providing relaxed standards (for example, for mercury) would encourage the burning of mercury contaminated wastes when combustion may not be the best technology to treat these types of wastes.
- Less stringent standards will provide a disincentive for pollution prevention and waste minimization. Small facilities are most likely to select waste minimization alternatives because of small quantities burned and higher costs of compliance.
- The amount of hazardous waste burning by on-site incinerators is large (50% more than all cement kilns). Sludges and solids form a major portion. Relaxing the standards may not be desirable.
- Closure of antiquated and poorly designed and operated facilities which cannot or do not want to modernize has been seen in other combustion areas like MWC, MWI, and BIFs. EPA has never relaxed standards on this basis. Moreover, closures will occur irrespective of whether the standards were relaxed. In the last couple of years, over 15 on-site HWIs have closed.

Commenters have raised many valid concerns regarding the direct environmental benefits of on-site incinerators, as well as the potential impacts of the shutdown of captive on-site

incinerators. However, cost analysis indicates 13 of 116 on-site incinerators may stop burning hazardous waste as a result of the final HWC MACT rule. It is likely that fewer than this projected number will actually stop burning hazardous waste. The number may be overestimated because EPA analysis indicates that, at the baseline, many currently operating on-site incinerators are projected to be non-profitable, so that this rule would not be the cause of a decision to stop burning hazardous waste. Additionally, it is projected that the required MACT retrofits will be achievable within the normal incinerator yearly down-time. Thus, there will be no major effect on production losses due to incinerator or process downtime.

Finally, for on-site incinerators that stop burning hazardous waste due to an unwillingness to make the necessary upgrades to meet the MACT standards, transfer of the waste to a MACT-compliant incinerator treatment system is an appropriate consequence.

This issue is evaluated in detail in the final rule preamble and response to comments document.

Incinerators Based on Design and Waste Type

Other comments proposed subdivision based on: (1) facility design, such as liquid injection incinerators and rotary kilns; or (2) waste type, such as mixed radioactive and hazardous wastes, munitions, liquid wastes, solid wastes, aqueous wastes, etc. However, this type of subcategorization is not used (as discussed in the response to comments document) because:

- By using the MACT EU concept, the MACT standards are generally based on a wide range of facilities operating under various conditions. Thus, the MACT standards are generally achievable by all types of incinerators burning all various waste-types when using MACT controls.
- The behavior of HAPs in the different incinerator types is generally comparable, and all MACT control strategies are generally applicable to all of the different combustor types:
 - PM -- Uncontrolled PM emissions levels are a function of both (1) the entrained PM rate which depends on incinerator design and operation (e.g., rotary kilns and fluidized bed incinerators typically have higher uncontrolled PM levels compared with stationary hearth starved air incinerators), and (2) the waste ash feed level. However, because MACT floor controls -- FF, ESP, and IWS -- are applicable to all types of incinerators and the MACT EU for which the standard is based contains

a range of incinerator types and waste ash levels, the MACT PM standard is achievable for all HW incinerators. For example, the PM standard is achievable by facilities with low uncontrolled PM loadings (such as liquid injection incinerators burning low ash content liquid wastes) as well as facilities with high uncontrolled PM levels (such as rotary kilns or fluidized beds burning high ash solids).

- CO/HC -- Commenters argue that different incinerator types have different CO/HC emission profiles and thus need different standards. However, the differences are not due to incinerator type; instead, they are based primarily on differences in system operation and waste type. The final rule MACT standards are based on good combustion practices and are universally achievable, appropriate, and applicable to all hazardous waste incinerator design types as well as all hazardous waste forms and types (i.e., the CO and HC MACT standards are universal indicators of adequate combustion efficiency). Potential “problem” systems (such as those using combustion gas rapid quenching or those burning highly aqueous waste streams, or rotary kilns burning heterogeneous volatile wastes) can meet the final MACT standards with proper system design and operation burning all types of wastes.
- Chlorine -- Subcategorization is not needed based on incinerator type. Chlorine has generally the same behavior in all different types of incinerators. It volatilizes completely from waste and is contained in the flue gas primarily as HCl with lower levels of Cl₂ and chlorinated organics. Subcategorization by waste type or chlorine content is not needed for similar reasons to those discussed for metals.
- Low Volatile and Semivolatile Metals -- For low volatile and semivolatile metals, subcategorization arguments can be made for different incinerator types which may have varying metals behavior and control due to differences in temperatures, PM entrainment rates, etc. However, subcategorization is not needed based on incinerator design/type because: (1) these differences do not generally have a major impact on uncontrolled metals emissions, and (2) the MACT EU contains a sufficient range of expected combinations of design and operation to be representative of the industry.
- Mercury -- Mercury has similar behavior to chlorine discussed above. Thus, no subcategorization is needed.

- PCDD/PCDF -- MACT floor control for PCDD/PCDF for incinerators is based on control of the combustion gas temperature profile through the downstream air pollution control system, as discussed in Chapter 4. Floor levels are determined independently for incinerators with waste heat boilers (and equivalent gas cooling methods such as heat exchangers) due to differences in temperature profiles (and PCDD/PCDF emissions levels) compared with incinerators that do not use waste heat boilers.

Primary chamber incinerator design (rotary kiln vs controlled air vs liquid injection vs fluidized bed) does not have a significant impact on the ability to control PCDD/PCDF emissions.

Waste type may have a secondary impact on PCDD/PCDF levels. For example, some wastes may contain PCDD/PCDF formation catalysts such as copper or PCDD/PCDF formation precursors such as chlorinated phenols and biphenyls. However, due to the lack of a major impact or the inability to subcategorize in this fashion, subcategorization by waste type is not necessary or appropriate. Additionally, the MACT EU contains conditions and facilities burning highly chlorinated wastes, and wastes with known PCDD/PCDF precursors (such as chlorinate phenols, benzenes, and biphenyls), and formation enhancers (such as copper, iron, etc.). That is to say, the MACT EU covers a wide range of different facilities burning many different waste types.

- If incinerators were subcategorized by incinerator type (design) or waste type, the resulting standards for the subcategories would be identical to or more stringent than those for the final rule's all inclusive incinerator category. More stringent standards was not the intent of the commenters when suggesting additional subcategorization is needed.
- Subcategorization is not needed based on incinerator type or waste type for many of the same reasons that subcategorization is not needed based on incinerator class or size, as previously discussed.
- There are other problems that are associated with the development and implementation of incinerator subcategories by type and waste. They include:

- It is not feasible to categorize in this manner. There would be too many subcategories to regulate. It would be difficult to handle facilities that burn a variety of wastes.
- There is not sufficient data for setting MACT floor standards for many potential subcategories (e.g., fluidized beds, controlled air systems, or special waste types).

Mixed Waste Incinerators

Mixed waste incinerators are not subcategorized (as discussed in the final rule preamble and response to comments document). Reasons for this include:

- There are sufficient trial burn data to assess impacts of the MACT rule on currently operating mixed waste incinerators (trial burn data are from all three mixed waste DOE incinerators, including the ORNL K-25 TSCA, the INEEL WERF, and the SRS CIF).
- MACT standards are currently being achieved or are reasonably achievable by mixed waste incinerators. The MACT control techniques for hazardous waste incinerators are technically applicable to mixed waste incinerators. Trial burn and performance test data are summarized in Table 2-3.
- PM and PM-associated MACT standards (including LVM and SVM) -- These standards are readily achievable for the CIF and WERF, which use HEPA filters. Upgrades may be needed for the ORNL WERF which uses an IWS-based PM control system. Thus, there is no technical limitation for mixed waste incinerators to meet the PM and PM-related metals standards.
- CO/HC -- All three facilities are meeting the MACT standards. Additionally, there are no special characteristics of mixed waste systems that would make them inherently unable to meet the CO/HC standard. For wastes that are more difficult to burn, such as those that are highly heterogeneous, volatile, flammable, or those that have low heating values, appropriate options for controlling CO/HC may include: homogenizing the waste (blending, sorting, size reduction), using auxiliary fuel, system overdesign, or “even” waste feeding (e.g., screw feeding as opposed to batch feeding).

- Chlorine -- The CIF and TSCA units that use wet scrubbing are meeting the standard. The WERF uses chlorine feedrate control only and will need further feedrate control or the addition of wet or dry scrubbing to meet the MACT floor. Generally, the MACT standard is achievable for systems using effective acid gas controlling wet scrubbers. There are no data to indicate that mixed wastes have chlorine levels high enough to prevent MW incinerator systems from meeting the standard with the use of wet scrubbing.
- Mercury -- The U.S. Department of Energy (DOE), who is responsible currently for the majority of mixed waste generation and treatment, indicates that there are some mixed wastes that have mercury levels that would result in uncontrolled mercury emissions above the MACT floor. They further indicate that it may be problematic to reduce mercury feedrates to MACT floor control levels as the technique to meet the floor.

However, feed control methods are available for mixed wastes. The Agency understands that mercury contaminated mixed wastes are being segregated and slated for treatment with methods particularly suited for mercury. These specialized mercury treatment methods include amalgamation and precipitation.

This is not to suggest that thermal treatment is not appropriate for mercury. In fact, thermally-based mercury retorters with mercury condensers and carbon beds are actually a common treatment method for mercury contaminated mixed wastes. Mixed waste “campaigning” and blending can also be used effectively to meet feed rate limit requirements.

Additionally, emission control equipment (in addition to feedrate control) can be used to meet the standard. Mercury control methods for mixed waste incinerators include carbon beds or carbon injection downstream of the primary PM control device. Carbon beds are appropriate for use on mixed waste incinerators:

- Carbon beds can be cost effective when applied to small units (in contrast to carbon injection).
- Carbon beds are commonly used for air cleaning on a variety of nuclear/radioactive facility operations, particularly for volatile radionuclide control (e.g., iodine).

- European and Japanese mixed waste incinerators commonly use carbon beds for the control of PCDD/PCDF, Hg, and volatile radionuclides. Because they can be positioned downstream of HEPA filters, they can have long lifetimes.
- An operating plasma arc treatment system at the INEEL uses a carbon bed. Most future conceptual system designs for thermal treatment systems specify the use of carbon beds.
- A recently shut down controlled-air hazardous waste incinerator at the Los Alamos National Laboratory used a carbon bed. The operating Glaxo mixed waste incinerator (Source ID No. 341) in North Carolina (which handles very low level radioactively contaminated wastes generated from medical research applications) uses a carbon bed.
- Carbon beds produce very little secondary mercury contaminated waste due to long lifetimes as a result of low PM and chlorine poisoning and the ability to operate near saturation conditions (as opposed to carbon injection where unused carbon is typically wasted before it becomes saturated).

Based on the variety of mercury-containing mixed waste treatment options, it is not projected that the HWC MACT rule will significantly affect DOE's total waste treatment time or the ability to meet currently agreed upon compliance schedules.

- PCDD/PCDF -- The TSCA unit is using MACT control and meeting the PCDD/PCDF standard. The WERF, which has a waste heat boiler, is not meeting the standard, like most existing incinerators with waste heat boilers. It is likely the WERF will need an upgrade consisting of the removal of the waste heat boiler, the addition of a rapid gas quench, or the use of carbon adsorption. The SRS CIF facility is apparently using the MACT control of rapid quench but not meeting the standard. But, as discussed in Chapter 3, it is believed that PCDD/PCDF formation is occurring either in the flue gas reheater prior to HEPA filtering (formation in a similar manner to that in waste heat boilers), or PCDD/PCDF is being released from the system due to the use of a scrubber with near zero liquid discharge. Some type of retrofit such as the addition of a carbon bed will likely be needed. Again, compared with conventional hazardous-only waste incinerators, there are no

technical limitations for using any of the PCDD/PCDF control methods on mixed waste incinerators.

- There are no conflicts between MACT control technology requirements and radionuclide control requirements under NESHAPs. Most DOE radionuclides are non-volatile constituents that are controlled identical to LVM through PM control strategies. In fact, radionuclides are a HAP under the Title III of the CAAA.
- In terms of potential mixed waste characterization limitations, there are many feasible alternatives available such as process knowledge, non-intrusive sampling and analysis, intrusive sampling and analysis with appropriate radiation protection measures, or use of CEMS which are being developed. Thus, characterization is not considered a problem.
- The MACT floor emissions levels are not based on risk or mass emissions but rather on achievability through the use of MACT. The MACT incinerator standards are considered to be fully achievable by mixed waste incinerators based on the previous HAP-by-HAP analysis.
- It is projected that DOE will continue to use thermal treatment-based methods for treatment of appropriate mixed wastes after the promulgation of this rulemaking. Moreover, currently agreed upon site treatment schedules will not be adversely impacted.

Cement Kilns

Some commenters suggest that cement kilns be subcategorized by wet vs dry types. EPA rejected this subcategorization because: (1) all kilns use similar types of raw materials, fuels, and wastes; (2) all kilns have similar HAP emissions types and levels; and (3) all kilns use, and can use, the same types of pollution control methods, to the same degree of effectiveness based on actual emissions data and theoretical considerations.

Commenters also suggested that cement kilns should be subcategorized by process type as: (1) short kilns with separate alkali bypass and main stacks; (2) short kilns with a combined alkali bypass and main stack; (3) long dry kilns that use in-line raw mills; and (4) others (including wet kilns and long dry kilns that do not use in-line raw mills). Consideration of subcategorization is necessary because the design and operation of cement kilns can impact emissions of certain HAPs, in particular semivolatile constituents such as cadmium and lead, CO and HC, and possibly PCDD/PCDF and PM (as described in Chapters 3 through 10).

EPA agrees that, in theory, emissions can be different from these different types of kilns. However, because the differences in kiln type do not affect the feasibility and effectiveness of the air pollution control technology, subcategorization is not needed to determine uniform achievable MACT standards. Specifically, as discussed below, it is shown that all types of different kilns are able to meet the MACT standards when using MACT control.

Furthermore, to account for the potential differences in emissions profiles and the limited number of kilns in the first three subcategories (short kilns and/or those with in-line raw mills), MACT floor control and emission levels are directly set based on the last “other” kiln category (including only those wet kilns and long dry kilns that do not use in-line raw mills). This category includes all but three of the waste burning cement kilns (one short kiln with separate main and bypass stacks, one short kiln with combined main and bypass stacks, and one long kiln with in-line raw mill). After the MACT floors were determined based on “long non in-line raw mill” kiln data, it was determined whether the other unique kiln types could apply MACT controls and achieve the MACT emissions levels (which they could, as discussed in Chapters 3 through 10). Although subcategorization was considered, EPA thus determined that a common set of MACT standards is appropriate for all cement kilns (i.e., short kilns and long kilns and those with in-line raw mills have the same common set of standards).

TABLE 2-1. STACK GAS EMISSIONS MEASUREMENT METHOD PRECISION

Pollutant	Measurement Method	Relative Standard Deviation (%)	Concentration Level (units)	Confidence Interval*		Units
				Upper (units)	Lower (units)	
PCDD/PCDF TEQ	Method 23	31%	0.2	0.14	0.26	ng TEQ/dscm
PM	Method 5i	3.6%	35	37	31	mg/dscm
			70	76	62	mg/dscm
HCl	Method 26	14%	130	148	111	ppmv
Metals						
Arsenic	Method 29	30%	20	26	14	µg/dscm
		35%	50	66	32	µg/dscm
Cadmium	Method 29	24%	60	70	42	µg/dscm
		22%	90	110	71	µg/dscm
Chromium	Method 29	50%	20	30	10	µg/dscm
		60%	70	112	28	µg/dscm
Lead	Method 29	30%	60	73	40	µg/dscm
		25%	90	114	70	µg/dscm
Mercury	Method 29, 101B	30%	25	30	16	µg/dscm
		19%	90	107	75	µg/dscm

* : 97.5% confidence that 99/100 measurements (3 run aver.) within the upper and lower range

TABLE 2-2. COMPARISON OF PCDD/PCDF AT FULL AND HALF NON DETECT

Cond ID	Syst Type	PCDD/PCDF (ng TEQ/dscm)			Summ Comments	Cond Date
		Full Det. Limit	Half Det. Limit	Difference Full - Half		
406C5	CK	0.000	0.000	0.000	Short, NLBHW, 1 run, ICM	11/1/90
406C5	CK	0.000	0.000	0.000	Short, BPM, NLBHW, 1 run, ICM	11/1/90
406C7	CK	0.000	0.000	0.000	Short, NLBHW, 1 run	11/1/90
406C6	CK	0.000	0.000	0.000	Short, B, NLBHW, 1 run, ICM	11/1/90
406C6	CK	0.001	0.001	0.000	Short, BPM, B, NLBHW, 1 run, ICM	11/1/90
904C3	Inc	0.001	0.001	0.001	WHB, 1 run, ICM	7/1/91
406C7	CK	0.001	0.001	0.000	Short, BPM, NLBHW, 1 run, ICM	11/1/90
208C1	CK	0.004	0.004	0.000		1/1/93
904C2	Inc	0.005	0.002	0.002	WHB, 1 run, ICM	7/1/91
347C2	Inc	0.005	0.003	0.002	B, 1 run	10/1/93
902C1	Inc	0.007	0.004	0.003	NLBHW	12/1/93
347C1	Inc	0.007	0.004	0.003		10/1/93
303C9	CK	0.007	0.007	0.000	Short, N, ILRM (off), CMBM	12/1/95
320C3	CK	0.008	0.007	0.001		8/1/95
478C1	Inc	0.008	0.006	0.002	Nor	8/13/96
477C5	Inc	0.008	0.006	0.002	Nor	8/13/96
354C2	Inc	0.009	0.009	0.000		4/1/92
321C3	CK	0.011	0.006	0.005	Short, ILRM (off), B, 1 run	10/13/93
303C8	CK	0.012	0.011	0.000	Short, ILRM (on), CMBM	12/1/95
805C3	Inc	0.012	0.010	0.002	Nor	8/13/96
706C3	Inc	0.013	0.012	0.001	1 run	5/3/88
321C4	CK	0.015	0.008	0.008	Short, ILRM (on), Nor, 2 runs	10/13/93
904C1	Inc	0.015	0.008	0.008	WHB, 1 run, ICM	7/1/91
207C1	CK	0.016	0.011	0.005		1/1/93
303C5	CK	0.017	0.009	0.007	Short, B, ILRM (on), CMBM	10/31/93
321C3	CK	0.017	0.015	0.002	Short, ILRM (off), BPM, B, 2 runs	10/13/93
480C1	Inc	0.019	0.015	0.004		5/31/94
222B3	Inc	0.019	0.018	0.001	WHB, Nor, CI	9/12/95
502C1	Inc	0.020	0.020	0.000	WHB, NLBHW	7/1/90
303C4	CK	0.021	0.013	0.008	Short, ILRM (on), CMBM	10/21/93
315C6	CK	0.022	0.018	0.004	Short, ILRM (off), B, NLBHW	4/16/91
206C9	CK	0.023	0.018	0.004	B	8/9/95
205C3	CK	0.024	0.020	0.004	B	8/1/92
347C3	Inc	0.026	0.014	0.012		4/1/92
706C2	Inc	0.028	0.024	0.004	2 runs	5/3/88
321C4	CK	0.029	0.022	0.007	Short, ILRM (on), BPM, Nor, 2 runs	10/13/93
500C1	Inc	0.031	0.016	0.015		7/18/88
315C2	CK	0.033	0.029	0.004	Short, ILRM (on), NLBHW	7/15/92
205C8	CK	0.033	0.027	0.006	Nor	8/9/95
222C7	Inc	0.033	0.033	0.000	WHB, Nor, CI	5/1/94
323C4	CK	0.034	0.033	0.001	RT, 2 runs	11/1/94
401C4	CK	0.036	0.034	0.002		3/1/94
323C2	CK	0.036	0.035	0.001	B, 2 runs	11/1/94
323C3	CK	0.037	0.036	0.001	RT, 2 runs	11/1/94

TABLE 2-2. COMPARISON OF PCDD/PCDF AT FULL AND HALF NON DETECT

Cond ID	Syst Type	PCDD/PCDF (ng TEQ/dscm)			Summ Comments	Cond Date
		Full Det. Limit	Half Det. Limit	Difference Full - Half		
348C3	Inc	0.037	0.035	0.002		4/16/95
323C5	CK	0.037	0.037	0.001	RT, 2 runs	11/1/94
402C3	CK	0.039	0.036	0.003		4/4/94
206C4	CK	0.040	0.040	0.000	B, 2 runs	8/1/92
347C4	Inc	0.040	0.023	0.018	B, 1 run	4/1/92
348C4	Inc	0.042	0.027	0.015		4/16/95
500C3	Inc	0.043	0.021	0.021		7/18/88
401C3	CK	0.044	0.043	0.001		3/1/94
206C8	CK	0.044	0.042	0.002	RT	8/9/95
315C1	CK	0.044	0.041	0.004	Short, ILRM, NLBHW	7/15/92
316C2	CK	0.046	0.043	0.003	Short, NLBHW, CMBM	3/25/92
401C5	CK	0.048	0.047	0.001		3/1/94
306C1	CK	0.053	0.047	0.006	NLBHW	5/1/93
322C9	CK	0.061	0.060	0.001	2 runs	11/1/95
331C1	Inc	0.064	0.057	0.007		3/1/93
319B4	CK	0.064	0.064	0.000	RT	8/23/93
348C2	Inc	0.066	0.066	0.001		4/16/95
216C7	Inc	0.066	0.038	0.029	ICM	2/1/90
202C4	CK	0.066	0.059	0.007	ILRM (on), 2 runs	4/1/94
222C5	Inc	0.067	0.065	0.002	WHB, Nor, CI	2/1/94
222C6	Inc	0.067	0.067	0.000	WHB, CI	4/1/94
322C8	CK	0.069	0.069	0.000		11/1/95
323B4	CK	0.070	0.070	0.000	2 runs	11/1/95
202C3	CK	0.070	0.057	0.013	ILRM (off), 2 runs	4/1/94
204C8	CK	0.078	0.078	0.000	1 run only	7/18/94
322C4	CK	0.080	0.078	0.002	B, 2 runs	8/9/93
315C5	CK	0.082	0.064	0.017	Short, ILRM (on), BPM, NLBHW	4/16/91
320C1	CK	0.089	0.089	0.000		8/1/92
344C3	Inc	0.090	0.050	0.040		2/1/93
206C7	CK	0.094	0.094	0.000	N	8/9/95
323B3	CK	0.097	0.097	0.000		11/1/95
214C1	Inc	0.098	0.081	0.017		4/28/87
221C4	Inc	0.102	0.099	0.004	1 run only	8/1/88
323B2	CK	0.103	0.103	0.000	RT	6/1/96
470C1	Inc	0.112	0.070	0.042		12/16/92
228C4	CK	0.120	0.098	0.021		7/1/93
315C5	CK	0.121	0.113	0.008	Short, ILRM (on), NLBHW	4/16/91
323C6	CK	0.123	0.122	0.001	RT, 2 runs	11/1/94
346C1	Inc	0.125	0.071	0.054		6/23/92
315C6	CK	0.127	0.100	0.027	Short, ILRM (off), BPM, B, NLRHW	4/16/91
315C4	CK	0.127	0.121	0.007	Short, ILRM (on), NLBHW	4/16/91
404B1	CK	0.128	0.118	0.009	RT, 2 runs	5/19/95
403C4	CK	0.128	0.128	0.000		11/1/94
402C4	CK	0.146	0.144	0.002		4/4/94

TABLE 2-2. COMPARISON OF PCDD/PCDF AT FULL AND HALF NON DETECT

Cond ID	Syst Type	PCDD/PCDF (ng TEQ/dscm)			Summ Comments	Cond Date
		Full Det. Limit	Half Det. Limit	Difference Full - Half		
471C1	Inc	0.150	0.150	0.000		3/1/95
304C3	CK	0.153	0.153	0.000	B	8/1/92
808C1	Inc	0.154	0.131	0.023	2 runs	2/10/88
319C9	CK	0.160	0.160	0.000	Nor	2/25/94
319D5	CK	0.161	0.160	0.001	RT	2/16/95
319B3	CK	0.163	0.163	0.000	RT	8/23/93
405C1	CK	0.167	0.153	0.014	Short, NLBHW, CMBM	8/1/92
403C3	CK	0.170	0.170	0.000		11/1/94
322C2	CK	0.171	0.169	0.001	2 runs	11/1/94
725C1	Inc	0.171	0.146	0.025		6/19/90
353C2	Inc	0.172	0.172	0.000		7/1/89
205C4	CK	0.200	0.200	0.000		8/1/92
221C2	Inc	0.200	0.195	0.005	1 run only	8/1/88
228C5	CK	0.207	0.207	0.000	RT, 2 runs	11/18/93
222C4	Inc	0.222	0.220	0.002	WHB, Nor, CI	7/30/93
304C6	CK	0.229	0.229	0.000	RT	7/18/94
404C3	CK	0.232	0.232	0.000		1/17/95
915C2	Inc	0.240	0.240	0.000		9/1/92
807C3	Inc	0.251	0.250	0.001	WHB, NLBHW	7/18/91
323B1	CK	0.261	0.261	0.000	B	6/1/96
315C2	CK	0.269	0.250	0.019	Short, ILRM (on), BPM, NLBHW	7/15/92
305B2	CK	0.286	0.280	0.007		8/11/95
319D1	CK	0.301	0.301	0.000	Nor	2/16/95
319D4	CK	0.307	0.307	0.000	RT	2/16/95
315C1	CK	0.324	0.297	0.027	Short, ILRM (on), BPM, NLBHW	7/15/92
404C6	CK	0.340	0.340	0.000	RT	11/18/93
319B1	CK	0.344	0.344	0.000	Nor	6/1/94
404C9	CK	0.352	0.339	0.013	RT, 2 runs	5/19/95
228C3	CK	0.380	0.380	0.000		5/1/92
221C1	Inc	0.385	0.376	0.009	1 run only	8/1/88
807C2	Inc	0.400	0.400	0.000	WHB, NLBHW	7/18/91
319D3	CK	0.406	0.405	0.000	RT	2/16/95
335C3	CK	0.418	0.418	0.000	B, 2 runs	9/19/94
467C1	Inc	0.466	0.244	0.222		10/6/87
204C2	CK	0.472	0.385	0.087		7/1/92
404C5	CK	0.494	0.494	0.000	2 runs	1/17/95
406C1	CK	0.503	0.442	0.061	Short, NLBHW, CMBM	8/1/92
323C7	CK	0.532	0.530	0.002	RT, 2 runs	11/1/94
315C4	CK	0.545	0.531	0.014	Short, ILRM (on), BPM, NLBHW	4/16/91
807C1	Inc	0.560	0.560	0.000	WHB, NLBHW	7/18/91
316C1	CK	0.579	0.576	0.003	Short, NLBHW, CMBM	3/25/92
335C2	CK	0.591	0.591	0.000	B (tires/coal), 2 runs	6/17/94
601C4	Inc	0.603	0.603	0.000	WHB, CI demo.	8/1/96
319B6	CK	0.635	0.634	0.001	B	8/23/93

TABLE 2-2. COMPARISON OF PCDD/PCDF AT FULL AND HALF NON DETECT

Cond ID	Syst Type	PCDD/PCDF (ng TEQ/dscm)			Summ Comments	Cond Date
		Full Det. Limit	Half Det. Limit	Difference Full - Half		
221C3	Inc	0.637	0.632	0.005	1 run only	8/1/88
915C3	Inc	0.680	0.680	0.000		9/1/92
334C1	Inc	0.690	0.655	0.036	WHB	9/6/90
319B5	CK	0.710	0.710	0.000	RT	8/23/93
335B1	CK	0.775	0.773	0.002		8/11/95
221C5	Inc	0.778	0.776	0.002	1 run only	8/1/88
303C7	CK	0.780	0.780	0.000	Short, ILRM (off), CMBM	12/1/95
327C5	Inc	0.807	0.807	0.000	RT	10/1/94
319D2	CK	0.822	0.822	0.000	RT	2/16/95
319B2	CK	1.012	1.012	0.000	Nor	8/23/93
402C1	CK	1.017	0.973	0.044		3/27/92
404C1	CK	1.018	0.975	0.042		11/1/92
601C3	Inc	1.019	0.789	0.231	WHB	5/1/96
335C4	CK	1.020	1.020	0.000	Nor, 2 runs	9/19/94
216C3	Inc	1.068	0.534	0.534	ICM	12/1/86
204C3	CK	1.097	1.056	0.040	B	7/1/92
325C4	Inc	1.105	0.891	0.214	ICM	12/1/90
317C2	CK	1.126	1.124	0.003	Short, ILRM (on), NLBHW	1/22/93
204C5	CK	1.138	1.138	0.000	Nor	7/18/94
319C5	CK	1.148	1.148	0.000	B, Cond. avg. only	12/1/90
322C6	CK	1.168	1.168	0.000	2 runs	8/9/93
222C2	Inc	1.213	1.213	0.000	WHB	5/1/93
300C3	CK	1.240	1.240	0.000	Nor	7/28/93
325C6	Inc	1.249	1.103	0.146	ICM	12/1/90
317C3	CK	1.319	1.319	0.000	Short, ILRM (on), B, NLBHW, 1 run	1/22/93
204C7	CK	1.347	1.347	0.000	RT	7/18/94
327C4	Inc	1.442	1.442	0.000	Nor	10/1/94
325C7	Inc	1.454	1.270	0.184	ICM	12/1/90
325C5	Inc	1.477	1.342	0.136	ICM	12/1/90
406C3	CK	1.490	1.490	0.000	Short, NLBHW, CMBM	8/1/95
323C9	CK	1.604	1.604	0.000	RT	6/1/96
401C1	CK	1.763	1.757	0.005		4/9/92
601C2	Inc	1.881	1.567	0.314	WHB	5/1/96
206C3	CK	1.982	1.980	0.002		8/1/92
325C9	Inc	2.090	2.090	0.000	RT	10/6/94
325A2	Inc	2.143	2.143	0.000	Nor	10/6/94
204C6	CK	2.179	2.179	0.000	RT	7/18/94
222C3	Inc	2.211	2.211	0.000	WHB	5/1/93
325C8	Inc	2.255	2.255	0.000	Nor, 2 runs	10/6/94
325A1	Inc	2.379	2.379	0.000	Nor	10/6/94
319B9	CK	2.700	2.700	0.000	Nor	10/23/91
601C1	Inc	3.065	3.000	0.065	WHB	5/1/96
404C4	CK	3.290	3.290	0.000		1/17/95
334C2	Inc	3.479	3.465	0.015	WHB	9/6/90

TABLE 2-2. COMPARISON OF PCDD/PCDF AT FULL AND HALF NON DETECT

Cond ID	Syst Type	PCDD/PCDF (ng TEQ/dscm)			Summ Comments	Cond Date
		Full Det. Limit	Half Det. Limit	Difference Full - Half		
222C1	Inc	3.599	3.599	0.000	WHB	5/1/93
322C1	CK	3.722	3.722	0.000		8/1/92
403C1	CK	3.819	3.785	0.034		10/1/92
406C4	CK	3.924	3.924	0.000	Short, NLBHW, CMBM	8/1/95
322C5	CK	4.387	4.387	0.000	Nor, 2 runs	8/9/93
914C1	Inc	4.390	4.390	0.000	NLBHW, 1 run	12/5/91
304C2	CK	4.533	4.533	0.000		8/1/92
229C1	Inc	4.806	4.796	0.011	WHB	4/16/91
203C1	CK	5.061	5.061	0.000	Incorrect APCD temp.	8/19/93
323C1	CK	5.179	5.179	0.000		8/1/92
319C7	CK	5.823	5.823	0.000	B, 1 run	12/1/90
319C6	CK	7.542	7.542	0.000	2 runs	12/1/90
322C7	CK	7.612	7.612	0.000	1 run	8/9/93
229C2	Inc	8.109	8.105	0.004	WHB	4/16/91
327C3	Inc	8.251	8.251	0.000		8/1/92
300C2	CK	10.973	10.962	0.011		8/20/92
309C4	CK	12.691	12.691	0.000	Cond. avg. only, NLBHW	8/1/94
327C2	Inc	17.917	17.917	0.000		8/1/92
319C2	CK	19.709	19.692	0.017		5/5/92
327C1	Inc	20.145	20.145	0.000		8/1/92
304C5	CK	24.162	24.084	0.078	Nor	9/29/94
335C1	CK	32.836	30.414	2.422		6/1/92
330C1	Inc	33.466	33.466	0.000	NLBHW	4/1/91
309C5	CK	33.505	33.505	0.000	Cond. avg. only, NLBHW	8/1/94
330C2	Inc	38.536	38.536	0.000	NLBHW, 2 runs	4/1/91
305C3	CK	49.198	49.198	0.000		8/20/92
309C1	CK	49.864	49.864	0.000	NLBHW	10/1/92

TABLE 2-3. DOE MIXED WASTE INCINERATOR PERFORMANCE SUMMARY

HAP	Units	INEEL WERF (1)		SRS CIF (2)			OR K-25 TSCA (3)	
		1	2	1	2	3	1	2
PM	gr/dscf	0.007	0.003	0.002	0.002	0.002	0.025	0.005
CO	ppmv	4	28	12	5	5	11	4
HC	ppmv							0.1
PCDD/PCDF	ng TEQ/dscm	4.7	43	12	3.1	1.7		0.01
Total chlorine	ppmv	808	526	0.7	1.2	0.82	11	
LVM	µg/dscm		10.8	8	5	7		
SVM	µg/dscm		3.5	22	8	10		
Hg	µg/dscm			5400	3400	3200		90

(1) Source ID No. 1000 -- Trial burn testing in 1997

(2) Source ID No. 602 -- Trial burn testing in 1997

(3) Source ID No. 357 -- Test cond. 1: Trial burn testing in 1990; Test cond. 2: Evaluation testing from M.P. Humphreys, V. Adams, E. Atkins, et al., "Informational Stack Emission Testing of a U.S. DOE Mixed Waste Incinerator in Preparation for Proposed Emission Limits Under the Draft EPA New Hazardous Waste Combustion Strategy," *89th Annual Meeting of the Air and Waste Management Association*, Paper No. 96-MP15A.01, Nashville, TN, June 23-28, 1996.

CHAPTER 3

POLYCHLORINATED DIOXINS AND FURANS

3.1 INCINERATORS

3.1.1 Existing Sources Floor

Table 3-1 summarizes PCDD/PCDF TEQ condition data from HWIs ranked by condition average. The table is divided into five sections: (1) conditions from “other” non waste heat boiler units using MACT floor control as discussed below, and currently burning waste; (2) conditions from “other” facilities that are not using MACT floor control; (3) conditions from units with waste-heat boilers; (4) conditions which are not considered in the MACT analysis due to an insufficient number of runs within the test condition or incomplete congener/isomer measurements; and (5) conditions from units that are no longer burning hazardous waste.

The data are from about 41 different HWIs, 36 of which are currently burning hazardous wastes. Test condition averages range widely from 0.01 to over 40 ng TEQ/dscm.

Control Methods

PCDD/PCDF is currently controlled at existing HWI facilities through a combination of:

- Rapid cooling of combustion gases and limiting the PM air pollution control device temperature to prevent low-temperature catalytic formation. PCDD/PCDF is known to form through catalytic reactions involving PM in the temperature range from about 400 to 700°F.
- Maintaining good combustion conditions by limiting the generation of potential PCDD/PCDF formation precursors such as polychlorinated biphenyls, benzenes, phenols, and other products of incomplete combustion (PICs). Good combustion is maintained on a

real-time basis through the monitoring and control of hazardous waste feed rate, hazardous waste composition, combustion temperature, CO and HC combustion gas levels, etc.

- Use of activated carbon to collect (adsorb) the PCDD/PCDF from the flue gas. This can be achieved using carbon beds or by injecting carbon and collecting it in a downstream PM APCD. The carbon injection method is currently being used by Source ID No. 222 on a full time basis and Source ID No. 601 on a pilot-scale experimental basis. Source ID No. 347 uses a carbon bed.
- To a lesser degree, the use of PM air pollution control devices (APCDs) to capture condensed and adsorbed PCDD/PCDF that is associated with the entrained particulate matter from the combustion zone (in particular, that which is adsorbed on unburned carbon-containing particulates). Types of APCDs typically include high energy wet scrubbers (most commonly venturi designs), wet or dry electrostatic precipitators (ESPs), and fabric filters (FF).

Note that because hazardous waste incinerator fly ash usually has very low levels of unburned carbon, PM control is not a dominant mechanism for PCDD/PCDF control. This is clearly evidenced by high-performance low-emitting PM facilities that have high PCDD/PCDF emissions due to use of waste heat boilers or higher temperature ESP or fabric filter operation (e.g., Source ID Nos. 222 or 325 or 327), compared with many low PCDD/PCDF emitting facilities that have higher levels of PM (between 0.03 and 0.08 gr/dscf). The lack of significant relationship between PM and PCDD/PCDF control is frequently found in the technical literature (e.g., Ullrich (1996b)).

Flue gas temperature control alone is used to define MACT floor control for existing incinerator PCDD/PCDF emissions. This is because flue gas temperature control has been widely shown to have the strongest and most universal impact on PCDD/PCDF emissions. Due to the weaker correlations between CO/HC or PM emissions levels with PCDD/PCDF stack gas emissions levels, these potential theoretical surrogates are not used as a basis to define MACT floor control (i.e., MACT for PCDD/PCDF is not based on the best performing CO/HC or PM sources, or those sources using MACT control for either PM or CO/HC).

Flue gas temperature control techniques in incinerators can be divided into three general classes:

- Systems that use rapid cooling of combustion gas to dewpoint saturation conditions (typical incinerator flue gas moisture saturation temperatures range from 150 to 200°F), followed by wet scrubbing for PM and acid gas control. PCDD/PCDF emissions from these types of sources range from 0.01 to 40 ng TEQ/dscm (although almost all measure less than 0.4 ng TEQ/dscm) and include most of the lowest emissions sources. This is likely due to inhibition of PCDD/PCDF catalytic formation downstream of the combustion chamber in the temperature range from about 400 to 700°F. The majority of on-site incinerators use this gas cooling method.
- Systems that use rapid combustion gas cooling with “dry” PM air pollution control devices such as ESPs or FFs (which have operating temperatures ranging typically from 350 to 550°F) followed by further gas cooling to saturation conditions and wet scrubbing. PCDD/PCDF emissions levels from these systems range from 0.15 to 20 ng TEQ/dscm, depending on the operating temperature of the dry APCD. Generally, emissions are higher at higher PM APCD temperatures. Most commercial type incinerators use this type of dual “wet/dry” system.
- Systems that are equipped with waste heat boilers or heat exchangers. Some incinerators utilize steam boilers (and other types of heat exchangers) for energy recovery and flue gas cooling prior to flue gas cleaning equipment (i.e., PM, metals, and chlorine APCDs). About 15% of the HWIs for which APCDs are known use waste heat boilers or heat exchangers. The presence of a boiler or heat exchanger provides conditions which can lead to PCDD/PCDF formation through the low-temperature catalytic mechanism (i.e., particulate hold-up on heat exchanger tubes and slow gas cooling through the catalytic PCDD/PCDF formation temperature region). Boiler outlet flue gas temperatures typically range from 400 to 600°F, and the temperature of particles deposited on the boiler tubes can vary widely depending on the local flue gas temperature, the water/steam temperature, and the thickness of the PM/soot deposits. PCDD/PCDF levels from HWIs with waste heat boilers and heat exchangers for which PCDD/PCDF data are available range from about 1 to 40 ng TEQ/dscm for those conditions for which carbon injection is not used. One of these systems uses carbon injection upstream of an ESP (with the carbon caught in the ESP), with PCDD/PCDF emissions levels ranging from 0.01 to 0.1 ng TEQ/dscm.

Based on these characteristics of PCDD/PCDF behavior in hazardous waste incinerators, incinerators are subcategorized for the evaluation of the PCDD/PCDF MACT floor as: (1) those equipped with waste-heat boilers or similar technology such as heat exchangers for combustion gas

cooling; and (2) “others”, comprised of all those that do not have waste-heat boilers or similar technologies.

Other Non-Waste Heat Boiler Systems

For “other” incinerators (those that do not have waste-heat boilers or heat exchangers), the best performing sources use cooling of combustion gases with water quenching sprays to gas saturation temperature followed by wet scrubbing for PCDD/PCDF control. Thus, MACT is defined as the cooling of combustion gases before the inlet of the primary PM air pollution control device to a temperature below 400°F (with or without the use of carbon injection or carbon beds), while avoiding “hold-up” of the gases in the catalytic PCDD/PCDF formation temperature zone. Cooling to a temperature of 400°F is considered to be sufficient for preventing the catalytic formation of PCDD/PCDF and thus generally equivalent to cooling to saturation temperatures, because PCDD/PCDF formation rates at temperatures less than 400°F have not been demonstrated to be significant.

Carbon adsorption is also used by one facility (ID No. 222) to control PCDD/PCDF to levels comparable to or lower than that achieved through temperature control alone (note that Source ID No. 347 uses a carbon bed, although historically the bed was not selected for PCDD/PCDF control, instead for volatile radionuclide control). Thus, the use of carbon absorption is considered as equivalent PCDD/PCDF control to temperature control alone. However, since carbon adsorption is not used by a minimum of 3 different sources, it can be used solely to define floor MACT control (MACT floor control is based on techniques used by the best 6% (or top 3) of sources).

PCDD/PCDF emissions from all other (non waste heat boiler like) incinerators using PCDD/PCDF MACT control (gas cooling to PM APCD temperature less than 400°F) are shown in Figure 3-1. Data are from 44 conditions and 26 different incinerators. Based on the performance of these MACT-like facilities, the MACT floor is set as either: (1) 0.4 ng TEQ/dscm combined with a primary PM APCD temperature limitation of less than 400°F; or (2) 0.2 ng TEQ/dscm. The floor level of 0.4 ng TEQ/dscm is based on the highest test condition average that is using MACT control (Source ID No. 603B3).

The PCDD/PCDF trial burn data used to set the MACT floor shown in Figure 3-1 represent a wide range of incinerator designs and waste types. They include:

- Rotary kiln units (from commercial and on-site facilities) burning a wide range of spiked solid and liquid wastes containing chlorinated organic compounds such as chlorobenzenes, polychlorinated biphenyls, carbon tetrachloride, and other organic constituents such as toluene considered to be (or PICs formed during their combustion) precursors to PCDD/PCDF formation. The commercial incinerators include Source ID Nos. 214, 221, 331, 603, 609, and 612. On-site incinerators include Source ID Nos. 353, 354, 480, 808, and 815.
- Fixed hearth controlled air units burning solid and liquid wastes (Source ID Nos. 470, 471, and 805).
- Liquid injection units burning chlorinated or non-chlorinated aqueous or organic liquid wastes from a variety of sources including pharmaceutical, chemical, agricultural, manufacturing, and military sources.
- Facilities burning highly chlorinated organic wastes. Facility Source ID Nos. 725 (Zeneca) and 467 (PPG at Lake Charles, LA) burn liquid organic wastes containing 50 to 80% chlorine by weight and including organics such as chlorophenols, PCBs, and carbon tetrachloride. Nonetheless, PCDD/PCDF emissions are less than 0.3 ng TEQ/dscm.
- Facilities burning explosives and chemical warfare agents.

Thus, the PCDD/PCDF MACT floor is currently being achieved by a wide variety of incinerator types, burning “worst-case” wastes (i.e., wastes most likely to result in PCDD/PCDF emissions), and using MACT floor control.

Note that there are four test conditions from three facilities that apparently use MACT control (combustion gas temperature control to less than 400°F) and have PCDD/PCDF emissions above the floor level of 0.4 ng TEQ/dscm. These conditions are not representative of MACT floor control practices:

- ID No. 221 (Rollins in Deer Park, TX) -- This site uses a rapid quench wet scrubbing system where the afterburner combustion gas at 2000+°F is rapidly cooled to saturation (less than 150°F) in a wet quench chamber. The quench is followed by a packed bed and venturi scrubbing. This facility has five different test conditions from an August 1988 testing program. PCDD/PCDF emissions levels from the five individual conditions are 0.1, 0.2, 0.38, 0.63, and 0.78 ng TEQ/dscm. The conditions differ in the waste feed

types, feed rates, feed locations, combustion temperature, and other operating parameters. Waste types included industrial wastes, sludges, and waste waters. The two highest conditions are not considered to be representative of MACT control because:

- Rollins has recently presented work indicating that a level of 0.2 ng TEQ/dscm is being achieved by all of their facilities using rapid quench wet scrubbing APCSS (Ullrich, 1996b; Ullrich, 1997). These results contradict the findings of the above described August 1988 test data. The Deer Park facility (Source ID No. 221) is currently reported to have a PCDD/PCDF level of 0.006 ng TEQ/dscm (based likely on more recent and/or more representative testing than the older August 1988 conditions in the current database). Additionally, other Rollins kilns with similarly designed rapid quench APCSS in Louisiana and New Jersey have both reported PCDD/PCDF levels of 0.08 ng TEQ/dscm (Ullrich, 1996b).
- Each of the different test conditions consisted of a single 3-hour sampling run, not the standard (and MACT required) average of 3 individual 3-hour runs. As single-run test conditions, they are not properly used to set MACT floors based on 3-run test series averages (i.e., the variability of single run conditions is much higher compared with 3-run averages and thus single run test conditions do not adequately represent the facility performance).
- PCDD/PCDF precursors generated from incomplete combustion of spiked carbon tetrachloride and solid waste and sludge organics may be responsible for the apparent PCDD/PCDF levels above the floor.
- The data are relatively old. Measurements were taken during the early stages of the use and development of EPA Method 23.
- ID No. 915 (Kodak in Rochester, NY) -- This facility has PCDD/PCDF data from 2 test conditions, with condition average levels of 0.7 and 0.25 ng TEQ/dscm (September 1992 trial burn). The thermal treatment system is apparently comprised of a rotary kiln/afterburner unit followed by a quench, venturi scrubber, and cyclone APCS. There is no indication of the use of any heat recovery gas cooling systems. The primary difference between the two test conditions is that during the condition associated with the 0.7 ng TEQ/dscm level, only the rotary kiln was fired (the afterburner was not used). Under more normal operating conditions represented by the condition with the PCDD/PCDF data of 0.25 ng TEQ/dscm, the afterburner is operated. Thus the 0.7 ng TEQ/dscm test condition

is not representative of normal facility operations. Additionally, PCDD/PCDF levels may be high because:

- Both conditions have relatively high CO (average of 100 with instantaneous peaks above 1000 ppmv) and low HC (less than 1 ppmv). Carbon tetrachloride, chlorobenzene, and toluene were spiked during both of the conditions. Chlorobenzenes (as well as chlorophenols and PCBs) are known PCDD/PCDF precursors. It is possible that high CO in combination with spiking of chlorobenzenes and toluene is responsible for the high PCDD/PCDF levels.
- Both conditions have relatively high oxygen levels (almost 15%); some work has indicated that the PCDD/PCDF levels increase as flue gas oxygen increases beyond about 10%.
- ID No. 603 (Chemical Waste Management in Port Arthur, TX) -- This site has PCDD/PCDF data from eight different test conditions conducted over four different time periods. One test condition (603C2) has a condition average of 0.53 ng TEQ/dscm. This test condition is not considered representative of PCDD/PCDF emissions from this facility due to a number of considerations, including: (1) the condition consisted of only two test runs; (2) all other condition averages are less than 0.4 (with five of the eight less than 0.2 ng TEQ/dscm); and (3) it is the oldest test data from the facility (i.e., more recent data is less than 0.4 ng TEQ/dscm).

Also, the Savannah River CIF mixed waste incinerator (ID No. 602), which uses combustion gas cooling to saturation conditions, has PCDD/PCDF emissions levels of 0.5 to 3.0 ng TEQ/dscm. However, these levels are not representative of MACT control since:

- Formation in the reheater -- The system has a coil-tube, steam-driven reheater (located downstream of the wet scrubbing) which is used to reheat the flue gas above saturation temperature (to about 250°F) prior to fine particulate HEPA filtering. The reheater tube wall temperatures which are exposed to the flue gas are estimated at about 500°F. The reheater tubes provide surface area for collection and hold-up of PM which escape the wet scrubber at a temperature where PCDD/PCDF have been shown to catalytically form. This facility may be more properly classified with those systems with waste heat boilers.
- Re-release in zero liquid discharge system -- To minimize liquid discharge (scrubber liquid “blowdown”) from the system, suspended solids and dissolved solids in the scrubber

water are allowed to rise to high levels (an order of magnitude higher than that of typical HWI scrubber blowdown operation). This provides an opportunity for captured PCDD/PCDF contained in the scrubber liquid and PM to build-up in the scrubber liquid or be re-released from the liquid as it is recycled back into the system for gas cooling and scrubbing purposes. This is indicated by scrubber water which had elevated PCDD/PCDF levels.

There are other factors that are known to be important to PCDD/PCDF formation and control in addition to flue gas temperature profile control. These include waste composition (including the level of PCDD/PCDF precursors and formation and destruction catalysts such as copper, iron, etc.), oxygen level, CO/HC levels, etc. Because these other parameters that influence PCDD/PCDF control are difficult to quantify and are not generally significant compared with gas cooling profiles, they are not used to define the MACT control and MACT floor.

For example, the presence of PCBs may be responsible for PCDD/PCDF emissions from Source ID No. 330. Source ID No. 330 (which is no longer operating, and thus not considered for setting the MACT floor) has two test conditions that have average PCDD/PCDF levels of 33 and 39 ng TEQ/dscm. The PCDD/PCDF floor is set at 0.4 ng TEQ/dscm. This source was burning waste oils with high levels of PCBs (30% by weight). The combustor was apparently operating at good combustion conditions (greater than 2000°F, greater than 2 seconds combustion gas residence time, and greater than 99.9999% PCB destruction efficiency) with rapid gas quenching (no waste heat boiler). The PCBs may be responsible for the formation of PCDD/PCDF either by themselves or by PICs generated during their combustion acting as formation precursors. However, these data are not directly used to set the MACT floor because: (1) this facility is no longer operating; and (2) as discussed in the next paragraph, these data are not consistent with the demonstrated performance of other incinerators which burn PCB contaminated wastes.

The presence of PCBs (or other suspected PCDD/PCDF precursors) does not necessarily translate to PCDD/PCDF levels above the MACT floor when using MACT control. There are a number of HWIs which burn PCB-contaminated wastes and use MACT control and have PCDD/PCDF levels less than the MACT floor of 0.4 ng TEQ/dscm. Source ID Nos. 346, 348, 603, and 825 are examples. There are also a number of Superfund site mobile incinerator units which burn PCB contaminated liquid, sludge, and solids, that have demonstrated PCDD/PCDF emissions less than 0.4 ng TEQ/dscm, as discussed in Chapter 12, Table 12-10. Note that other facilities, including Source ID Nos. 601, 229, 325, and 327, burn PCBs and have PCDD/PCDF emissions ranging from 1 to 11 ng TEQ/dscm. Because all of these facilities also have waste heat

boilers and/or high temperature dry PM collection devices, it is not possible to directly attribute the PCDD/PCDF levels to the presence of PCBs.

Note also, in the May 1997 NODA revised MACT standards analysis, it was mistakenly thought that Source ID No. 334 (3M in Cottage Grove, MN) had two “outlier” test conditions (334C1 and 334C2) with PCDD/PCDF levels of 0.7 and 3.5 ng TEQ/dscm. Subsequently, it has been determined that this facility has a waste heat boiler followed by a wet scrubbing APCS. Thus, these two conditions were removed from the “other” rapid quench subcategory and appropriately considered in the “waste heat boiler” subcategory discussed in the next section.

Waste Heat Boiler and Heat Exchanger Systems

PCDD/PCDF emissions from waste heat boiler equipped incinerators are shown in Figure 3-2 (including those conditions from Source ID Nos. 222 and 601, which have waste heat boilers and are using carbon injection). Condition average emissions from those that are not using carbon injection range from 1 to 8 ng TEQ/dscm, with one condition (Source ID No. 1000C2) at 40 ng TEQ/dscm.

PCDD/PCDF MACT floor control for incinerators with waste heat boilers is defined as control of the primary PM APCD temperature to below 400°F (cooling of the flue gas leaving the boiler to below 400°F prior to entering any PM control devices), based on the control procedures used by the best three sources (average of the best performing 12% of sources or at least the best five).

All of the test conditions shown in Figure 3-2 are included as part of the MACT expanded universe because they are all using MACT floor control. The MACT floor is set as either: 12 ng TEQ/dscm and limiting PM APCD temperature to less than 400°F, or 0.2 ng TEQ/dscm. Note that due to the relatively limited dataset from only a couple of facilities, the floor level option of 12 ng TEQ/dscm is based on the highest individual run from all of the available conditions (not considering the one high test condition at 40 ng TEQ/dscm, which is not used due to receipt of the data at a late date in the rulemaking process).

Note that activated carbon for PCDD/PCDF control is used on only one facility on a full-time basis. As for “other” incinerators, because it is not used on the best 6% (or at least top 3) of existing facilities, it is not used to define MACT for existing sources. However, note that, as discussed below for new sources, this technology consistently achieves levels less than 0.2 ng TEQ/dscm at Source ID No. 222 (WTI in East Liverpool, OH).

Beyond-the-Floor Considerations for Waste Heat Boiler Facilities

EPA considered beyond-the-floor standards for PCDD/PCDF of both 0.2 and 0.4 ng TEQ/dscm for incinerators with waste heat boilers. The beyond-the-floor levels of 0.2 and 0.4 ng TEQ/dscm are both based on the use of activated carbon (either in injection or bed applications). PCDD/PCDF control efficiencies of about 97 to 98% are required to meet these beyond-the-floor levels, based on the PCDD/PCDF floor for incinerators with waste heat boilers of 12 ng TEQ/dscm. PCDD/PCDF control efficiencies in this range are readily achievable with the use of activated carbon:

- As discussed in Chapter 14, activated carbon injection is being effectively used for PCDD/PCDF control (as well as mercury and other organics control) on many municipal and medical waste incinerators and on one hazardous waste incinerator (which also has a waste heat boiler). PCDD/PCDF control efficiencies when applied to high inlet PCDD/PCDF levels are greater than 99% with corresponding controlled stack gas emissions of typically less than 0.2 ng TEQ/dscm. PCDD/PCDF control efficiencies with the use of carbon beds have also been shown in limited applications to be consistently greater than 99% (as expected, better than carbon injection).
- The one hazardous waste incinerator currently using activated carbon injection (Source No. 222) is consistently achieving PCDD/PCDF levels of less than 0.1 ng TEQ/dscm, with estimated control efficiencies ranging from 95 to 99% (based on approximate inlet uncontrolled levels ranging from 1 to 4 TEQ ng/dscm, from testing prior to the addition of the activated carbon injection system).
- Control efficiency is affected by a variety of operating parameters, including: (1) activated carbon injection rate, where increased injection rate will generally lead to increased control efficiency, (2) activated carbon PCDD/PCDF adsorption characteristics, (3) mixing effectiveness between activated carbon and flue gas, (4) control efficiency of injected activated carbon, and (5) flue gas and injected carbon temperature, where lower temperatures will generally result in high control efficiency.

The beyond-the-floor standard of 0.4 ng TEQ/dscm is chosen based on cost-effectiveness considerations, as discussed in the final rule preamble (and *Technical Support Document for HWC MACT Standards, Volume V: HWC Emissions Estimates and Engineering Costs*). That is to say, the level of 0.4 ng TEQ/dscm was determined to be cost effective, while the level of 0.2 TEQ

ng/dscm was not determined to be cost effective due to small incremental reductions achieved when compared with the beyond the floor level of 0.4 ng TEQ/dscm.

3.1.2 New Sources Floor

MACT for new sources is based on the use of activated carbon injection. It is used on a full-time basis by hazardous waste incinerator Source ID No. 222 and on a pilot-scale basis by Source ID No. 601. The floor level based on activated carbon injection is 0.2 ng TEQ/dscm, from the following considerations:

- Activated carbon injection has been shown to achieve on a consistent basis PCDD/PCDF levels less than 0.2 ng TEQ/dscm on a variety of waste combustion systems, including medical waste incinerators and municipal waste combustors. The level of 0.2 ng TEQ/dscm is generally consistent with the MWC MACT standard, which is also based on activated carbon control method.
- Generally, the level of 0.2 ng TEQ/dscm is achievable regardless of source type (i.e., with or without waste-heat boilers or “uncontrolled” PCDD/PCDF emissions levels).
- HWI Source ID No. 222 (with a waste heat boiler) currently consistently achieves less than 0.07 ng TEQ/dscm. However, due to the limited application of carbon injection on other hazardous waste incinerators and the uncertainties in performance at low PCDD/PCDF emissions concentrations, the level of 0.2 ng TEQ/dscm has been determined to be conservatively representative of activated carbon performance.

Note that the majority of rapid combustion gas cooling wet scrubber systems meet this new source level. However, this control is not chosen for MACT because some rapid cooling incinerators have emissions levels that are sometimes higher than those achievable with carbon injection.

3.2 CEMENT KILNS

3.2.1 Existing Sources Floor

Data

Table 3-2 summarizes all PCDD/PCDF TEQ test condition data from CKs ranked by condition average. The table is divided into four sections: (1) data from long non-in-line raw mill

kilns; (2) data from short or in-line raw mill kilns; (3) data from cement kilns no longer burning hazardous waste; and (4) data from conditions that are not considered in the MACT analysis due to an insufficient number of runs within the test condition (i.e., less than 3 runs).

The data are from about 35 different hazardous waste burning CKs. PCDD/PCDF data are available from almost all of the hazardous waste burning cement kilns. The exceptions are Giant Cement in Harleyville, SC (Source ID Nos. 200 and 201) and Texas Industries in Midlothian, TX (Source ID No. 318). Test condition averages range widely from 0.004 to nearly 50 ng TEQ/dscm. The PCDD/PCDF data set for CK typically contains multiple conditions from each facility.

Data are also included for 14 test conditions from non hazardous waste burning cement kilns (designated with a “NHW” descriptor in the Table 3-2 EPA Cond. ID column). These include 8 conditions from long cement kilns and 6 conditions from short cement kilns. The cement kiln company name and location are given in the summary comments column for each of the test conditions. The source of these data are documented in the recently finalized MACT rule for the Portland Cement Manufacturing Industry (64 FR 31898; June 14, 1999). Note that for short kilns, it is not clear if the PCDD/PCDF data are from main, bypass, or combined main/bypass stacks.

Temperature Control

Many factors potentially affect PCDD/PCDF formation and emissions in a cement kiln. It has been speculated that formation may occur in the kiln or preheater unit, in the transition region from the kiln exit to the APCD, in the APCD, etc. However, reducing flue gas temperature in the PM control device is one factor shown to consistently have a significant impact on limiting PCDD/PCDF formation. Flue gas temperature reduction prevents the well-demonstrated low-temperature catalytic formation process. Additionally, EPA-sponsored testing on a hazardous waste burning cement kiln showed that PCDD/PCDF was not present at significant levels prior to the APCD (EER, 1995). It has been well documented that PCDD/PCDF in existing CKs is controlled primarily by limiting PM air pollution control device temperature, which is very similar to and consistent with PCDD/PCDF behavior demonstrated in other waste combustion systems, including municipal waste combustors and medical waste incinerations. See Figure 3-4 and Chapter 3 of the accompanying *Technical Support Document for HWC MACT Standards: Volume IV, Compliance* for more data supporting the relationship.

A number of kilns have recently added flue gas quenching units upstream of the PM APCD to reduce the inlet APCD temperature. These additions have significantly reduced PCDD/PCDF levels. This is based on information from the individual sites, source test data, and information supplied to the EPA by the Cement Kiln Recycling Coalition. In particular, water spray systems have been added to kilns at the Medusa Wampum, Ash Grove Foreman, Lafarge Fredonia, River Cement Festus, Holnam Clarksville, and Ash Grove Chanute sites specifically to reduce APCD temperatures. All retrofits have resulted in reduced PCDD/PCDF levels. Other kilns, including LoneStar Cape Greencastle, have also reduced inlet temperatures to the APCD by process modifications and water spray quench to limit PCDD/PCDF emissions.

Raw Materials Impact

It has been suggested that PCDD/PCDF emissions from CKs can also be significantly affected by the release of PCDD/PCDF contained in the raw material feed streams. This is potentially supported by testing at Continental Cement where:

- Shale was replaced with fire clay, with a corresponding PCDD/PCDF reduction of 11 to 0.5 ng TEQ/dscm;
- APCD temperature reduction showed little effect on PCDD/PCDF emissions;
- Raw materials PCDD/PCDF content was shown to be significant and variable;
- Raw materials PCDD/PCDF feed levels were shown to be as much as twice as high as PCDD/PCDF stack gas emissions levels; and
- PCDD/PCDF were detected upstream of the APCD.

It is also potentially supported by data shown in Table 3-3, where PCDD/PCDF stack gas and raw materials levels from five cement kilns are provided.

It is acknowledged that in theory naturally occurring PCDD/PCDF contained in the raw material can, to some extent, contribute to the total PCDD/PCDF stack emissions. However, EPA considers the contribution of PCDD/PCDF from raw materials to be insignificant relative to the amount that is formed via surface catalyzed reactions in the dry APCD. Further, there is no strong evidence that PCDD/PCDF contained in raw materials will impede the ability to meet the PCDD/PCDF floor emissions level. Reasons for this are discussed below.

The data in Table 3-3 actually indicates that PCDD/PCDF in raw materials is not likely significantly related to PCDD/PCDF stack gas emissions levels because:

- Kiln A has one test condition (A-1) at high kiln outlet (and APCD) temperature, and one test condition (A-2) at low kiln outlet (and APCD) temperature. The condition with higher APCD temperature has much higher (100 times) stack gas emissions levels compared with the lower temperature condition, supporting the significant impact of temperature profile on PCDD/PCDF emissions. Both conditions have similar raw materials PCDD/PCDF feed levels. Also, stack gas emissions are much lower than raw material feedrates, indicating that raw materials PCDD/PCDF “destruction” may be taking place. Additionally, a third “normal” test condition has the highest raw materials feedrate levels of the three conditions, but the lowest stack gas emissions.
- For kilns B, C, and E, the raw material PCDD/PCDF levels are much less than the stack gas emissions levels, clearly suggesting that some formation mechanism other than PCDD/PCDF contained in raw materials is responsible for cement kiln PCDD/PCDF stack gas emissions.
- For kiln D, for two test conditions, raw materials feedrates are similar, while stack gas emissions levels vary by more than a factor of three.

Also note that any mass balance that is attempted on naturally occurring PCDD/PCDF in the raw material is suspect because of the uncertainties involved with sampling and analyzing PCDD/PCDF that are present at such low concentrations, but which are contained in raw materials that are fed at such high feedrates.

Additionally:

- As discussed above, APCD temperature and kiln gas cooling profile have been repeatedly demonstrated to have a significant and dominant impact on controlling cement kilns PCDD/PCDF emissions.
- Recent comprehensive and well controlled testing has shown that PCDD/PCDF emissions upstream of the APCD are low, and that PCDD/PCDF formation occurring across the APCD is a strong function of APCD temperature.

- The PCDD/PCDF congener/isomer “profile” of the raw materials is vastly different than that of the stack gases. In fact, the raw material profile is dominated by OCDD/OCDFs, which do not generally show up in the stack gas to the same degree.

Note that only one cement kiln has seen significant reductions of PCDD/PCDF when switching from raw material shale to fire clay. This was done to meet the BIF HC standard; it is not clear if APCD temperature was reduced as well. Certainly, EPA suspects that a reduction in HC emissions (in this case through raw materials alterations) will reduce PCDD/PCDF (and other organics PIC) emissions. However, data are not provided to show either: (1) a relation between PCDD/PCDF in shale and fire clay and stack gas emissions, or (2) that raw materials PCDD/PCDF levels will prevent meeting the MACT floor when operating with APCD temperatures of less than 400°F.

Other Control Methods

Other factors, such as type and effectiveness of PM air pollution control devices to capture condensed and adsorbed particulate PCDD/PCDF and combustion conditions (like CO and HC levels) also can have an effect on PCDD/PCDF control. However, these are not significant compared to APCD and flue gas temperature profiles.

For PM, an evaluation of the CoC test burn data indicates that control of PM does not have a strong impact on PCDD/PCDF emissions. This is most clearly seen because some lower PM emitters have high PCDD/PCDF emissions, whereas many higher PM emitters have low PCDD/PCDF. This is likely because PCDD/PCDF is mainly present in the vapor phase of the stack gases, as supported by the following observations:

- EPA’s Report to Congress on Cement Kiln Dust (CKD) analyzed CKD data from five cement kilns burning hazardous waste. The data indicate that PCDD/PCDF are present at “very low concentrations in CKD generated by both hazardous and non-hazardous waste fuel burning facilities.” (page 3-38, Report to Congress on CKD, Volume II: Methods and Findings, December 1993). Projecting these PCDD/PCDF concentrations in the CKD to the flue gas (assuming each cement kiln was emitting at a PM level of 0.030 gr/dscf (approximately equivalent to the MACT level)) shows that the stack gas PM-related level of PCDD/PCDF is also very low. The PM-related contribution of PCDD/PCDF to emissions is projected to range from only 0.00025 ng TEQ/dscm to 0.0000006 ng TEQ/dscm. Low PCDD/PCDF levels are in part because CKD has low carbonaceous content.

- Under good combustion conditions and minimizing low temperature catalytic formation, PCDD/PCDF is present at levels well below theoretical saturated vapor pressures. Thus, PCDD/PCDF is not expected to condense due to vapor pressure considerations (i.e., it will be present as unsaturated vapor).
- The use of activated carbon efficiently controls PCDD/PCDF emissions. Activated carbon directly adsorbs PCDD/PCDF (and other organic) vapors.
- Method 23 stack gas sampling train data on municipal waste combustors indicate that PCDD/PCDF is found primarily in the XAD of the sampling train (which contains adsorbed PCDD/PCDF vapors), as opposed to that contained in the PM which is removed in the initial filter.

Floor Evaluation

MACT floor control for existing cement kilns is temperature control at the inlet to the “dry” PM control device. As discussed above, there is a strong relationship between PCDD/PCDF emissions and dry PM control device temperature. Control of PCDD/PCDF through APCD temperature control by existing cement kilns is evident through: (1) recent research demonstration tests conducted at a couple of different hazardous waste cement kilns involving the successful use of APCD temperature reduction to control PCDD/PCDF emissions; and (2) current (“baseline”) PCDD/PCDF emissions from hazardous waste burning cement kilns that have been greatly reduced over the last few years due solely to APCD temperature reductions at a number of kilns mentioned in a previous paragraph.

Also, note that existing RCRA BIF regulations require all hazardous waste burning cement kilns to establish a maximum flue gas temperature at the inlet to the PM control device. See Section 266.103(c)(viii). The BIF rule also requires PCDD/PCDF source testing for those kilns which chose to operate at dry PM APCD temperatures of from 450-750°F.

Based on the relationship between dry PM APCD operating temperature and PCDD/PCDF emissions, MACT floor control for CKs is defined as limiting the primary PM control device (ESP or FF) temperature to less than 400°F. This type of control is used by the average of the best performing 12% of existing sources to control PCDD/PCDF. Selecting an upper limit APCD inlet temperature of 400°F to define MACT floor control is based on:

- Reduction below this level does not provide significant PCDD/PCDF emissions reductions.

- Levels below 350°F can cause dew point condensation problems which lead to APCD corrosion, cake cementing, and dust handling problems.
- PCDD/PCDF formation is accelerated at levels above 400°F. It has been shown that an increase in APCD temperature of about 125°F corresponds to an increase in PCDD/PCDF emissions by an order of magnitude for a typical cement kiln facility. See Chapter 3 of the accompanying *Technical Support Document for HWC MACT Standards, Volume IV: Compliance*.
- This temperature level is readily achievable. There is no technical limitation to operating at temperatures less than 400°F. Note that:
 - Six different kilns at three different sites are currently operating at APCD temperatures of less than 400°F.
 - About 20% of all test conditions have APCD temperatures below 400°F.

The MACT floor is set as achievement of either: (1) an emissions level of 0.2 ng TEQ/dscm; or (2) an emissions level of 0.4 ng TEQ/dscm in combination with a requirement to maintain the APCD temperature below 400°F. These levels are based on the following data:

- Figure 3-3 shows PCDD/PCDF emissions levels from long cement kilns (without in-line raw mills) with APCD temperatures of less than 400°F. Data are from the following hazardous waste burning cement kilns: Source ID Nos. 401 and 402 at Ash Grove Chanute, 228 and 403 at Ash Grove Foreman, 322 and 323 at Lafarge Fredonia. Also data are from eleven non-hazardous waste burning cement kilns. All but three are achieving an emissions level of 0.2 ng TEQ/dscm.
- The highest PCDD/PCDF emissions level from a CoC trial burn test condition of any long, non in-line raw mill, cement kiln burning hazardous waste with an APCD temperature of less than 400°F is 0.28 ng TEQ/dscm (Source ID No. 402C6). The highest PCDD/PCDF emission level from a compliance test condition from any long, non in-line raw mill, non hazardous waste cement kiln with an APCD temperature less than 400°F is 0.37 ng TEQ/dscm (Condition NHW9, from Lehigh Cement, Union Bridge, MD).

As described at the end of this section, both hazardous waste burning CK and non hazardous waste burning CK PCDD/PCDF data were considered together because both data sets are adequately representative of general PCDD/PCDF behavior and control in either type of kiln. This similarity is based on our engineering judgment that HW burning does not have an impact on PCDD/PCDF formation, as PCDD/PCDF are formed predominately post-combustion. Though the highest PCDD/PCDF emissions data point from MACT hazardous waste and non hazardous waste kilns varies somewhat, it is our judgment that additional emissions data, irrespective of HW burning status, would continue to point to a floor within the range of 0.28 to 0.37 ng TEQ/dscm.

- Figure 3-4 shows PCDD/PCDF emissions as a function of APCD temperature for all the different kiln types, hazardous wastes, and baseline conditions. The best fit of the long kiln hazardous waste firing data corresponds to a level of about 0.2 ng TEQ/dscm at a temperature of 400°F. The 0.4 ng TEQ/dscm level is conservatively above the best fit line. (Note that, for conditions with stack temperature only, it was assumed that the APCD temperature was 50°F above the stack temperature. In addition, for cement kilns with multiple APCDs in parallel (e.g., kilns with bypasses), the average of the APCD temperature weighted by flue gas flow rate is shown.)
- Of all of the data, there are only three conditions where the PCDD/PCDF levels are above 0.4 ng TEQ/dscm when the APCD is below 400°F. These data are not considered for the following reasons:
 - Source ID No. 323C7, with an average emissions level of 0.53 TEQ ng/dscm at an elevated APCD temperature of 400°F, was “research” evaluation testing with only two runs conducted. Commenters generally supported the exclusion of data for test conditions with less than three runs. In addition, this source has many other conditions with levels well below 0.4 ng TEQ/dscm. These conditions include ID Nos. 323C3, C4, C5, C6, B1, B2, and B3.
 - Source ID Nos. 335C2 and C4 have apparent stack temperatures of about 330°F with TEQ levels of 0.59 and 1 ng TEQ/dscm, respectively. The actual APCD temperature is not available. These conditions both had only 2 runs each, and therefore we excluded these data. ID No. 335C2 was conducted with coal and tire firing, while ID No. 335C4 was a “normal” hazardous waste condition. Neither were conduct as part of CoC testing.

- According to the information in their test report, Source ID No. 203C1 had an apparent APCD temperature of 383°F with a PCDD/PCDF emissions level of approximately 5 ng TEQ/dscm. This APCD temperature is likely too low:
 - The simultaneously measured stack gas temperature of 515°F taken during the PCDD/PCDF Method 23 testing was much higher than the APCD temperature. Flue gas reheating may take place to some degree through the induced draft fan. However, the stack gas temperature is typically from 20 to 70°F lower than the APCD temperature. For this reason, the actual APCD temperature was likely above 500°F.
 - The Method 23 source testing train thermocouple is likely to be more accurate than the plant thermocouple used at the APCD inlet due to more recent calibration and cleaning.
 - Commenters recommend using the higher temperature.
 - The PCDD/PCDF emissions level is clearly much higher than that observed for other conditions with APCD temperatures less than 400°F.
- Condition NHW10, from Lehigh, Union Bridge, MD, is from a kiln which does not burn hazardous waste. It has an emissions level of 1.2 ng TEQ/dscm at a stack gas temperature of 358°F. This condition is not used to set the MACT floor because: (1) it is likely that the PM APCD temperature is over 400°F; (2) poorly controlled combustion/kiln operation may be responsible for non-representative PCDD/PCDF levels; and (3) this same kiln has another condition with PCDD/PCDF at 0.37 ng TEQ/dscm. This is consistent with the decision made for setting the PCDD/PCDF MACT floor for non-hazardous waste burning cement kilns. See 64 FR 31898 (June 14, 1999).
- Short kilns and/or those with in-line raw mills can also meet the floor level of 0.4 ng TEQ/dscm:
 - Source ID No. 303, a short kiln (and in-line raw mill) with a combined bypass and main stack, is much below (less than 0.02 ng TEQ/dscm) the floor level during operation with its raw mill active and main and bypass FF temperatures of 180 and 420°F. With the raw mill off and elevated main and bypass FF temperatures of 355

and 441°F respectively, the PCDD/PCDF level is above the floor (0.78 ng TEQ/dscm). It is projected that at lower APCD temperature, like those with the raw mill on, the floor level is achievable. Note that the main stack APCD temperature is controllable through a water quench spray tower to MACT levels of less than 400°F when the raw mill is off-line.

- Source ID No. 321, a short kiln with a separate bypass and main stack, meets the floor emission level at both stacks (PCDD/PCDF measurements of 0.01 to 0.02 ng TEQ/dscm), with and without the raw mill in operation. The raw mill status does not have an impact on APCD temperature or PCDD/PCDF emissions.

Note that the bypass stack gas has lower potential HC precursors compared with the main stack because there are no contributions from raw material organics desorption and incomplete oxidation. Also, the bypass gas has a different temperature profile. Commonly, water quench is used for cooling. The rapid cooling, compared with slower cooling through the kiln and preheaters, reduces the potential for PCDD/PCDF formation in the bypass compared with the main stack. Although, if air dilution and duct radiation cooling is used in the bypass, the opposite may be true. Note additionally that bypass and main stack data are available for one kiln (Source ID No. 315, which is no longer burning hazardous wastes). The bypass data are approximately 0.25 TEQ ng/dscm and the main stack is about 0.03 ng TEQ/dscm. However, this is not unexpected since the bypass APCD is about 75°F above the main stack APCD.

- Source ID No. 202, a long kiln with in-line raw mill, has PCDD/PCDF data at less than 0.1 ng TEQ/dscm both with and without the raw mill in operation.
- About 70% of all test conditions (regardless of APCD operating temperature) are less than 0.4 ng TEQ/dscm. About 50% of all test conditions are less than 0.2 ng TEQ/dscm.
- Based on the site specific PCDD/PCDF data and PCDD/PCDF reduction of an order of magnitude per 125°F drop in PM APCD temperature, it is projected that all of the kilns can meet the PCDD/PCDF floor level of 0.4 ng TEQ/dscm by operating with an APCD temperature of less than 400°F. In addition, most cement kilns will be able to meet a 0.2 ng TEQ/dscm level when controlling the inlet temperature to the APCD to less than 400°F. This is shown in Figure 3-4 and demonstrated in many site-specific evaluations of the effect of APCD temperature on PCDD/PCDF emissions.

- The floor level can be met by kilns burning worst-case PCDD/PCDF precursor wastes (e.g., highly chlorinated organic wastes). For example, the AshGrove and Lafarge kilns.

The PCDD/PCDF data from hazardous waste burning and “baseline” non-hazardous waste burning cement kilns are pooled because there is no consistent effect of hazardous waste fuels compared with conventional fuels (typically coal) on PCDD/PCDF emissions. PCDD/PCDF emissions data from fourteen kilns with and without HW firing are available. No consistent trend is shown in Chapter 12, Figure 12-2. For seven of the kilns, the baseline levels are about the same as those with hazardous wastes. For five of the kilns, emissions with hazardous waste are 3 to 30 times higher than baseline. For two of the comparisons, baseline emissions are significantly higher than those with hazardous wastes. It has been argued that PCDD/PCDF emissions with hazardous waste are higher than baseline coal-only due to typically elevated chlorine levels in hazardous wastes (particularly when chlorine spiking is performed in the CoC test burns). However, recent comprehensive testing has shown that, in cement kilns, the chlorine feedrate has no significant effect on PCDD/PCDF emissions (EER, 1995). Other factors are more important.

3.2.2 New Sources Floor

The definition of MACT for new sources is the same as for existing sources -- reduction of temperature at the primary PM APCD to below 400°F. No currently operating hazardous waste burning cement kiln uses activated carbon for controlling PCDD/PCDF. Because the APCD temperature control method used by the best single controlled source is the same that used by the best 6% of sources, the definition of MACT floor control for new CKs is identical to that for existing sources. The new source floor is therefore the same as for existing sources -- either: (1) an emissions level of 0.2 ng TEQ/dscm; or (2) an emissions level of 0.4 ng TEQ/dscm in combination with a requirement to maintain the APCD temperature below 400°F.

3.3 LIGHTWEIGHT AGGREGATE KILNS

Table 3-4 summarizes all PCDD/PCDF TEQ test condition data from LWAKs, ranked by condition average. The data are limited to 5 test conditions, 2 of which are from the same kiln and have only 2 and 1 runs each. Data are available from 3 of the 15 different hazardous waste burning LWAKs. Condition averages range widely from 0.04 to 2.9 ng TEQ/dscm. The two lowest emissions results are from tests at Source ID No. 336 in 1994. The middle condition is from recent compliance testing conducted by Solite in 1996. The two highest conditions are from demonstration testing co-sponsored by EPA/OSW in 1997.

All available PCDD/PCDF data were generated at similar APCD (FF) inlet temperatures of around 400°F. Thus, it appears that APCD operating temperature may not have a strong effect on PCDD/PCDF emissions. As discussed above, a strong correlation between APCD temperature and PCDD/PCDF emissions has been shown conclusively for incinerators and cement kilns. However, PCDD/PCDF data from the highest emitting LWAK source (ID No. 223C50) is from a LWAK unit which quenches the gas exiting the kiln to about 600°F. This rapid gas cooling is followed by a long uninsulated transfer duct in which the flue gas cools very slowly from 550°F to 390°F before entering the FF. The gas residence time in the duct is about 7 seconds. It is surmised that the long flue gas residence time in this temperature region is conducive for low temperature catalytic PCDD/PCDF formation and is responsible for the elevated PCDD/PCDF levels. This is supported by relatively high levels of PCDD/PCDF found in the collected FF dust. Thus, the flue gas temperature profile, as well as the APCD operating temperature, is important for controlling PCDD/PCDF emissions in LWAKs.

The importance of the flue gas cooling profile is confirmed by subsequent EPA-sponsored testing at the same kiln (ID No. 223C51). This testing involved further water quenching at the kiln exit to cool the kiln exit gas to a temperature of about 450°F. This is about 100°F cooler than the initial test (ID No. 223C50). Note that the FF operating temperatures of the two series were identical because the second set of tests was conducted in very hot weather, which decreased gas cooling in the uninsulated transfer duct. Compare this with the first set which was conducted in very cold weather resulting in a large amount of gas cooling. A reduction of the PCDD/PCDF level from 1.7 to 0.5 ng TEQ/dscm was seen in the two testing series. This reduction is consistent with the effect of temperature control on PCDD/PCDF reduction that has been demonstrated for other waste combustors such as municipal waste combustors, medical waste incinerators, cement kilns, and hazardous waste incinerators.

It is worth noting that for the two highest emitting EPA demonstration testing conditions, the FF was thoroughly cleaned prior to each of the individual tests runs. The filter cake was knocked off to aid in the evaluation of lime injection's ability to control chlorine emissions. It is speculated that these data may not be representative of PCDD/PCDF levels normally obtained under typical test burn operations and filter cake buildup. Levels are projected to be lower under operations with normal cake buildup due to enhanced PM filtering and collection ability.

3.3.1 Existing Sources Floor

MACT for PCDD/PCDF for LWAKs for existing sources is defined, analogous to cement kilns, as limiting the primary APCD temperature to less than 400°F, based on the operation of the three LWAKs with PCDD/PCDF data. It is also based on demonstrated operating temperatures for all LWAK APCDs (all FFs) during CoC testing, as shown in Table 3-5. LWAK APCD operating temperatures range from 325 to 450°F (maximum test condition average). 5 of 15 (33%) facilities have demonstrated during CoC testing the capability of operating at APCD temperatures of less than 400°F. There is no technical basis for the inability to operate below 350 to 400°F. In fact, the Solite LWAKs all use, or have available, FF “tempering” air dilution and water quench for cooling kiln exit gases (at about 1000°F at kiln exit) prior to the FF, in addition to uninsulated duct radiation cooling. Thus, the capability of operating at FF temperatures of less than 400°F is currently available. Note that they are all under or very close to 400°F under current operations. The Norlite LWAKs have available air dilution dampers for gas cooling prior to the FF as well, in addition to heat exchangers used for cooling the kiln exit gas at a temperature of about 1000°F to the FF operating temperature of about 400°F.

The PCDD/PCDF MACT floor for PCDD/PCDF for existing LWAKs is based on all of the available PCDD/PCDF test conditions except Source ID No. 314C50, which does not strictly meet the MACT definition because its FF is operating at a temperature of 417°F, and ID No. 223C51, which is research testing and not representative of current LWAK operations. Due to the very small data set, as was done for incinerators with waste heat boilers, the MACT floor is established as the highest individual run in the expanded universe data set -- 4.1 ng TEQ/dscm, and a dry PM APCD temperature limit of 400°F, or alternatively to meet a level of 0.2 ng TEQ/dscm.

Again note that the 4.1 ng TEQ/dscm was based on the highest individual test run within the expanded universe conditions (226C50), and that the test condition average is given in Table 3-4. (Note that subsequent to this floor determination, it has been noticed that the results of this test condition were improperly reported. The actual highest individual test run within test condition 226C50 is 2.3 ng TEQ/dscm.)

3.3.2 New Sources Floor

The definition of MACT for new sources is the same as for existing sources -- reduction of temperature at the primary PM APCD to below 400°F. This is because the best performing source is using similar PCDD/PCDF control procedures compared with the best 3 sources. The new

source floor is also the same as that for existing sources -- 4.1 ng TEQ/dscm, and an APCD temperature limit of 400°F, or alternatively to meet a level of 0.2 ng TEQ/dscm.

3.3.3 Beyond the Floor for Existing and New Sources

For existing and new source LWAKs, a PCDD/PCDF beyond the floor level of either 0.4 ng TEQ/dscm and operation of air pollution control device less than 400°F, or 0.2 ng TEQ/dscm, is determined to be cost effective.

The beyond the floor level is based on the use of rapid cooling of kiln exit flue gases to less than 400°F. Insulation of the flue gas transfer ducting between the kiln exit and the APCD inlet, which is lengthy in some LWAKs, may be needed to prevent dew point condensation problems in the APCD and stack.

Achievement of PCDD/PCDF emission levels below 0.4 ng TEQ/dscm with gas cooling is based on the EPA testing described in Section 3.3.1 previously. The testing indicated that a reduction in kiln exit flue gas temperature of 600 to 460°F produced a reduction in PCDD/PCDF emissions of 1.7 to 0.5 ng TEQ/dscm. This is a 70% reduction in PCDD/PCDF emissions corresponding to a 140°F reduction in temperature. PCDD/PCDF emissions are projected to be at 0.3 ng TEQ/dscm when the gas temperature is further quenched to less than 400°F. This is somewhat lower than the beyond the floor level of 0.4 ng TEQ/dscm.

Note that the PCDD/PCDF reductions achieved by lowering the quench temperature from 600 to 460°F is somewhat lower than that observed from other waste burning source categories. However, it is fully consistent with the expected trend. Lower reductions may be in part because FF bag cleaning immediately prior to each test run did not allow a good filter cake buildup and thus PCDD/PCDF adsorbed onto PM may have been emitted at higher than normal rates. Nonetheless, even the observed reduction in PCDD/PCDF emissions indicates that 0.4 ng TEQ/dscm is readily achievable when the temperature is reduced to less than 400°F.

Achievement of a beyond the floor level of 0.4 ng TEQ/dscm is also supported by PCDD/PCDF data from two currently operating LWAKs, as shown in Table 3-5 -- specifically, less than 0.1 ng TEQ/dscm from Source ID No. 336, and 0.25 ng TEQ/dscm from Source ID No. 314.

The achievability of the beyond the floor level is further supported by communications from Norlite that their LWAKs (ID Nos. 307 and 479) have demonstrated PCDD/PCDF levels of

less than 0.2 ng TEQ/dscm. (This data is not included in the table or database and used directly in the MACT floor analyses because the actual test reports have not been provided to EPA). Note that these kilns use heat exchangers for cooling the kiln exit gases to the FF operating temperature of about 400°F.

TABLE 3-1. INCINERATOR PCDD/PCDF

EPA Cond ID	APCS Type	TEQ D/F ng/dscm	APCD Temp (°F)	Stack Temp (°F)	Summ Comm	Cond Date	Syst Type	Size Class	Cond Descr
Part 1. "Other" (non waste heat boiler) facilities using MACT floor control and currently burning hazardous waste									
1002C1	C/QT/VS/PBS/DM	0.001				8/1/97	OS	S	Trial burn
347C8	C/QT/VS/PBS/DM	0.002				4/9/97	OS	S	Trial burn
493C1	VS/PT	0.002				7/7/97	OS	S	Trial burn
347C1	C/QT/VS/PBS/DM	0.004		231		10/1/93	OS	S	Compliance test ("normal" for metals, VX agent fee
609C1	WS	0.004				4/1/95	Comm	L	RCRA trial burn
477C5	QT/PT/VS/D	0.006		178	Nor	8/13/96	OS	L	PCDD/PCDF evaluation, normal
478C1	Q/VS/DM	0.006		187	Nor	8/13/96	OS	L	PCDD/PCDF evaluation, normal
603C5	WQ/WS/IWS	0.006				1/1/92	Comm	L	RCRA trial burn
494C50	VS/PT	0.007				4/1/95	OS	S	Trial burn, 1997 Inc. Conf.
603C3	WQ/WS/IWS	0.007				1/1/92	Comm	L	RCRA trial burn
354C2	QC/AS/VS/DM/IWS	0.009		89		4/1/92	OS	L	RCRA trial burn (min. kiln temp., max. chlorine, wa
805C3	QT/QS/VS/ES/PBS	0.010		189	Nor	8/13/96	OS	L	PCDD/PCDF evaluation, normal
603C4	WQ/WS/IWS	0.010				1/1/92	Comm	L	RCRA trial burn
347C3	C/QT/VS/PBS/DM	0.014				4/1/92	OS	S	Compliance test ("normal" for metals, HD agent fee
480C1	QC/HS	0.015		185		5/31/94	OS	L	Trial burn to modify existing RCRA permit
357C50	VS/IWS	0.015			Nor	9/15/95	OS	L	Demo testing, 1996 AWMA Conf.
500C1	QC/VS/KOV/DM	0.016		174		7/18/88	OS	L	RCRA trial burn (max. comb. temp., min. organic c
500C3	QC/VS/KOV/DM	0.021		172		7/18/88	OS	L	RCRA trial burn (min. comb. temp., max. organic c
603C6	WQ/WS/IWS	0.025				1/1/90	Comm	L	RCRA trial burn
348C4	QC/AS/IWS	0.027		86		4/16/95	OS	S	RCRA trial burn (normal metals, low comb. temp., i
467C51	C/S	0.033				6/1/96	OS	S	Demo testing, 1997 Inc. Conf.
348C3	QC/AS/IWS	0.035		94		4/16/95	OS	S	RCRA trial burn (max. comb. temp., max. waste fe
494C1	VS/PT	0.036				8/15/97	OS	S	Trial burn
344C3	QC/VS/PT/DM	0.050		197		2/1/93	OS	S	Demo test burn (HD feed)
467C52	C/S	0.052				10/1/95	OS	S	Demo testing, 1997 Inc. Conf.
331C1	PT/IWS	0.057		122		3/1/93	Comm	L	State test burn
348C2	QC/AS/IWS	0.066		92		4/16/95	OS	S	RCRA trial burn (min. comb. temp., max. waste fee
470C1	QT/VS/PBS/DM	0.070		193		12/16/92	OS	S	RCRA trial burn (HD-mustard ton containers)

TABLE 3-1. INCINERATOR PCDD/PCDF

EPA Cond ID	APCS Type	TEQ D/F ng/dscm	APCD Temp (°F)	Stack Temp (°F)	Summ Comm	Cond Date	Syst Type	Size Class	Cond Descr
346C1	C/QC/VS/PT/DM	0.071		181		6/23/92	OS	L	RCRA trial burn (M55 VS Rockets)
214C1	Q/IWS	0.081		96		4/28/87	Comm	L	RCRA trial burn
603B2	WQ/WS/IWS	0.099				1/1/90	Comm	L	RCRA trial burn
612C1	FF	0.104				1/21/97	Comm	L	RCRA trial burn
467C50	C/S	0.130				10/1/95	OS	S	Demo testing, 1997 Inc. Conf.
725C1	WS/QT	0.146		158		6/19/90	OS	S	RCRA trial burn
471C1	QT/FF	0.150		235		3/1/95	OS	S	RCRA trial burn (Agent GB/Dunnage)
353C2	QC/VS/DM/WESP	0.172				7/1/89	OS	L	RCRA trial burn (max. kiln temp., max. chlorine, w/
603C1	WQ/WS/IWS	0.210				1/1/90	Comm	L	RCRA trial burn
915C2	QC/VS/C	0.240				9/1/92	OS	L	RCRA trial burn (min. comb. temp., PCC and SCC,
467C1	C/S	0.244				10/6/87	OS	S	Test burn
603B3	WQ/WS/IWS	0.410				1/1/94	Comm	L	RCRA trial burn
915C3	QC/VS/C	0.680				9/1/92	OS	L	RCRA trial burn (min. comb. temp., PCC only)

Part 2. "Other" facilities not using MACT floor control and burning hazardous waste

327C5	SD/FF/WS/WESP	0.81	448	149	RT	10/1/94	Comm	L	PCDD/PCDF evaluation (APCD temp. and sulfur a
327C4	SD/FF/WS/WESP	1.44	433	155	Nor	10/1/94	Comm	L	PCDD/PCDF evaluation of APCD temp.
325C9	SD/FF/WS/IWS	2.09	430	100	RT	10/6/94	Comm	L	Evaluation testing (min. APCD temp.)
325A2	SD/FF/WS/IWS	2.14	460	98	Nor	10/6/94	Comm	L	PCDD/PCDF evaluation w/ CI, normal
325A1	SD/FF/WS/IWS	2.38	460	99	Nor	10/6/94	Comm	L	PCDD/PCDF evaluation w/out CI, normal
327C3	SD/FF/WS/WESP	8.25	467	148		8/1/92	Comm	L	RCRA trial burn (max. heat input)
327C2	SD/FF/WS/WESP	17.92	466	146		8/1/92	Comm	L	RCRA trial burn (max. sludge feed)
327C1	SD/FF/WS/WESP	20.15	470	145		8/1/92	Comm	L	RCRA trial burn (max liquid feed)

Part 3. Waste heat boiler facilities using MACT floor control and burning hazardous wastes

222B3	WHB/SD/CI/ESP/Q/PBS	0.02		194	WHB, Nor, CI	9/12/95	Comm	L	Annual performance test, normal waste and operat
222C50	WHB/SD/CI/ESP/Q/PBS	0.02			WHB, Nor, CI	8/1/94	Comm	L	Quarterly testing w/ CI, normal
222C51	WHB/SD/CI/ESP/Q/PBS	0.02			WHB, Nor, CI	12/1/94	Comm	L	Quarterly testing w/ CI, normal
222C7	WHB/SD/CI/ESP/Q/PBS	0.03	383	199	WHB, Nor, CI	5/1/94	Comm	L	Quarterly testing w/ CI, normal

TABLE 3-1. INCINERATOR PCDD/PCDF

EPA Cond ID	APCS Type	TEQ D/F ng/dscm	APCD Temp (°F)	Stack Temp (°F)	Summ Comm	Cond Date	Syst Type	Size Class	Cond Descr
222C5	WHB/SD/CI/ESP/Q/PBS	0.07	383	188	WHB, Nor, CI	2/1/94	Comm	L	Quarterly testing w/ CI, normal
222C6	WHB/SD/CI/ESP/Q/PBS	0.07	359	197	WHB, CI	4/1/94	Comm	L	RCRA trial burn repeat (max. waste and ash feed)
704C3	WHB	0.19			WHB	2/16/94	OS	S	
334C3	WHB/WS/WESP/PT	0.19			WHB	3/11/88			
222C4	WHB/SD/CI/ESP/Q/PBS	0.22	382		WHB, Nor, CI	7/30/93	Comm	L	Preliminary CI testing, normal
601C4	WHB/DS/CI/FF/WS	0.60		168	WHB, CI demo.	8/1/96	Comm	L	Demonstration of carbon injection system
334C1	WHB/WS/WESP/PT	0.65		76	WHB	9/6/90	OS	L	RCRA trial burn (max. chlorine and heat input)
601C3	WHB/DS/FF/WS	0.79	350	166	WHB	5/1/96	Comm	L	RCRA trial burn
222C2	WHB/SD/ESP/Q/PBS	1.21	385	201	WHB	5/1/93	Comm	L	RCRA trial burn (max. sludge feed)
601C2	WHB/DS/FF/WS	1.57	350	167	WHB	5/1/96	Comm	L	RCRA trial burn
602C3	WQ/WS/RH/HEPA	1.70		187	MW, reheater	7/15/97	OS	S	RCRA trial burn
602C1	WQ/WS/RH/HEPA	1.94		190	MW, reheater	7/15/97	OS	S	RCRA trial burn
222C3	WHB/SD/ESP/Q/PBS	2.21	380	201	WHB	5/1/93	Comm	L	RCRA trial burn (max. solid feed, min. SCC temp.)
601C1	WHB/DS/FF/WS	3.00	350	164	WHB	5/1/96	Comm	L	RCRA trial burn
602C2	WQ/WS/RH/HEPA	3.10		183	MW, reheater	7/15/97	OS	S	RCRA trial burn
334C2	WHB/WS/WESP/PT	3.46		76	WHB	9/6/90	OS	L	RCRA trial burn (min. heat input)
222C1	WHB/SD/ESP/Q/PBS	3.60	411	202	WHB	5/1/93	Comm	L	RCRA trial burn (max. temp, metals, and chlorine f
1000C1	HE/FF/HEPA	4.70			MW, HE	10/1/97	OS	S	DOE INEEL WERF Inc., low temp cond.
229C1	WHB/ACS/HCS/CS	4.80		159	WHB, 488°F at WHB exi	4/16/91	OS	S	RCRA trial burn
229C2	WHB/ACS/HCS/CS	8.10		163	WHB, 510°F at WHB exi	4/16/91	OS	S	RCRA trial burn
1000C2	HE/FF/HEPA	47.00			MW, HE	10/1/97	OS	S	DOE INEEL WERF Inc., high temp cond.

Part 4. Conditions that are not adequate for MACT purposes (incomplete measurements or insufficient runs)

347C2	C/QT/VS/PBS/DM	0.003		232	B, 1 run	10/1/93	OS	S	Baseline -- no waste treated
706C3	QT/HS/C/DM	0.012		179	1 run	5/3/88	OS	S	RCRA trial burn (min. waste feed)
347C4	C/QT/VS/PBS/DM	0.023		219	B, 1 run	4/1/92	OS	S	Baseline -- no waste treated
706C2	QT/HS/C/DM	0.024		184	2 runs	5/3/88	OS	L	RCRA trial burn (min. feed rate, comb. temp.)
221C4	SS/PT/VS	0.099		118	1 run only	8/1/88	Comm	L	RCRA trial burn
808C1	QT/PBS/WESP	0.131		132	2 runs	2/10/88	OS	L	RCRA trial burn (min. heat input, comb. temp.)

TABLE 3-1. INCINERATOR PCDD/PCDF

EPA Cond ID	APCS Type	TEQ D/F ng/dscm	APCD Temp (°F)	Stack Temp (°F)	Summ Comm	Cond Date	Syst Type	Size Class	Cond Descr
221C2	SS/PT/VS	0.195		124	1 run only	8/1/88	Comm	L	RCRA trial burn
221C1	SS/PT/VS	0.376		121	1 run only	8/1/88	Comm	L	RCRA trial burn
603C2	WQ/WS/IWS	0.532			2 runs only, old data	1/1/90	Comm	L	RCRA trial burn
221C3	SS/PT/VS	0.632		123	1 run only	8/1/88	Comm	L	RCRA trial burn
221C5	SS/PT/VS	0.776		128	1 run only	8/1/88	Comm	L	RCRA trial burn
325C8	SD/FF/WS/IWS	2.255	450	100	Nor, 2 runs	10/6/94	Comm	L	Evaluation testing, normal
904C3	WHB	0.001		443	WHB, 1 run, ICM	7/1/91	OS	S	RCRA trial burn
904C2	WHB	0.002		359	WHB, 1 run, ICM	7/1/91	OS	S	RCRA trial burn
904C1	WHB	0.008		361	WHB, 1 run, ICM	7/1/91	OS	S	RCRA trial burn
216C7	HES/WS	0.038		81	ICM	2/1/90	Comm	L	RCRA trial burn
216C3	HES/WS	0.534		102	ICM	12/1/86	Comm	L	State trial burn
325C4	SD/FF/WS/IWS	0.891	450		ICM	12/1/90	Comm	L	RCRA trial burn (max. waste feed)
325C6	SD/FF/WS/IWS	1.103	450		ICM	12/1/90	Comm	L	RCRA trial burn (max. sludge and solid feed)
325C7	SD/FF/WS/IWS	1.270	450		ICM	12/1/90	Comm	L	RCRA trial burn (VOC and metals spike)
325C5	SD/FF/WS/IWS	1.342	450		ICM	12/1/90	Comm	L	RCRA trial burn (max. sludge feed)

Part 5. Facilities no longer burning hazardous waste

902C1	QT/VS/PT	0.004		183	NLBHW	12/1/93	OS	L	RCRA trial burn
502C1	WHB/QC/PBC/VS/ES	0.020		73	WHB, NLBHW	7/1/90	OS	S	RCRA trial burn (max. waste feed, min. comb. temp)
807C3	C/WHB/VQ/PT/HS/DM	0.250		194	WHB, NLBHW	7/18/91	OS	L	RCRA trial burn (starved air mode, max. waste feed)
807C2	C/WHB/VQ/PT/HS/DM	0.400		194	WHB, NLBHW	7/18/91	OS	L	RCRA trial burn (oxidizing mode, max. waste feed)
807C1	C/WHB/VQ/PT/HS/DM	0.560		189	WHB, NLBHW	7/18/91	OS	L	RCRA trial burn (oxidizing mode, min. waste feed)
914C1	SD/FF/WS	4.390		203	NLBHW, 1 run	12/5/91	OS	L	RCRA trial burn
330C1	QT/PBS/DM	33.466		169	NLBHW	4/1/91	Comm	S	PCB trial burn (HCl eval.)
330C2	QT/PBS/DM	38.536		170	NLBHW, 2 runs	4/1/91	Comm	S	PCB trial burn (PCB DRE)

TABLE 3-2. CEMENT KILN PCDD/PCDF

EPA Cond ID	D/F TEQ ng/dscm	APCS Temp (°F)	Stack Temp (°F)	Summ Comments	Cond Descr	Cond Date
Part 1. Long non in-line raw mill kilns						
NHW7	0.00		305	B, NHWBCK, Holnam, Florence, CO		
NHW11	0.00		396	B, NHWBCK, Riverside, OroGrande, CA		
208C1	0.00	410	334		CoC testing (max. prod. rate)	1/1/93
320C3	0.01	477	396		CoC testing (max operat. cond.)	8/1/95
NHW12	0.01		403	B, NHWBCK, Riverside, OroGrande, CA		
207C1	0.01	419	327		CoC testing (max. prod. rate)	1/1/93
NHW14	0.02		397	B, NHWBCK, Capital Aggregates, SanAntonio, TX		
206C9	0.02	NA	390	B	Baseline, normal APCD temp.	8/9/95
205C3	0.02	470	367	B	CoC testing (baseline)	8/1/92
205C8	0.03	NA	403	Nor	"Normal" haz waste cond.	8/9/95
401C4	0.03	296	207		CoC testing (min. comb. temp. and max. waste feed)	3/1/94
402C3	0.04	277	287		CoC testing (min. comb. temp.)	4/4/94
206C8	0.04	NA	363	RT	"Normal" haz waste, low APCD temp.	8/9/95
401C3	0.04	379	266		CoC testing (max. waste feed)	3/1/94
401C5	0.05	366	256		CoC testing (max. comb. temp and waste feed)	3/1/94
305C50	0.05		460		Initial July 1992 CoC stack test	7/8/92
319B4	0.06	NA	476	RT	Eval. of water injection and sodium carbonate addition	8/23/93
322C8	0.07	380	331		CoC testing (max operat. cond.)	11/1/95
NHW8	0.07		315	B, NHWBCK, AshGrove, Montana City, MT		
NHW13	0.07		450	B, NHWBCK, LoneStar, Ogelsby, IL		
320C1	0.09	485	368		CoC testing (max. prod. rate, max. comb. temp.)	8/1/92
206C7	0.09	NA	382	N	"Normal" haz waste cond.	8/9/95
323B3	0.10	423	392		CoC testing (max operat. cond.)	11/1/95
228C4	0.10	381	365		CoC testing (low comb. temp DRE test)	7/1/93
302C50	0.10	NA	370		CoC testing?	8/18/94
323B2	0.10	359	NA	RT	Evaluation (high chlorine, low APCD temp.)	6/1/96
403C4	0.13	375	NA		Trial burn (low comb. temp, high haz waste feed)	11/1/94
402C4	0.14	351	322		CoC testing (max. prod. rate, min. ESP power)	4/4/94

TABLE 3-2. CEMENT KILN PCDD/PCDF

EPA Cond ID	D/F TEQ ng/dscm	APCS Temp (°F)	Stack Temp (°F)	Summ Comments	Cond Descr	Cond Date
304C3	0.15	NA	420	B	CoC testing (baseline)	8/1/92
319C9	0.16	426	426	Nor	PCDD/PCDF evaluation	2/25/94
319D5	0.16	NA	533	RT	Eval. of sulfur addition	2/16/95
319B3	0.16	NA	530	RT	Eval. of addition of sodium carbonate	8/23/93
403C3	0.17	431	NA		Trial burn (high comb. temp, high chlorine)	11/1/94
205C4	0.20	470	369		CoC testing (low APCD temp.)	8/1/92
304C6	0.23	434	420	RT	Pre CoC testing to evaluate new ESP (runs at diff. APCD	7/18/94
404C3	0.23	415	430		Trial burn (low comb. temp., high chlorine feed)	1/17/95
323B1	0.26	404	NA	B	Baseline eval. (low chlorine, high APCD temp.)	6/1/96
305B2	0.28	413	253		CoC testing (low APCD temp.)	8/11/95
402C6	0.28	302	279		CoC testing (min. comb. temp., max . prod. rate)	7/1/92
319D1	0.30	NA	523	Nor	Baseline waste testing	2/16/95
319D4	0.31	NA	462	RT	Eval. of water injection and insufflation	2/16/95
404C6	0.34	457	NA	RT	PCDD/PCDF evaluation	11/18/93
319B1	0.34	462	459	Nor	PCDD/PCDF evaluation	6/1/94
NHW9	0.37		346	B, NHWBCK, Lehigh, Union Bridge, MD		
228C3	0.38	460	449		CoC testing (max. APCD temp.)	5/1/92
204C2	0.38	597	501		CoC testing (max. comb. temp.)	7/1/92
319D3	0.41	NA	478	RT	Eval. of water injection	2/16/95
203C50	0.44	485	390		CoC testing (max. waste feed)	8/16/96
319B6	0.63	NA	479	B	Diagnostic testing	8/23/93
319B5	0.71	NA	467	RT	Eval. of water injection	8/23/93
335B1	0.77	413	348		CoC testing (low APCD temp.)	8/11/95
204C52	0.79	480	414		CoC	9/13/96
319D2	0.82	NA	523	RT	Eval. of carbon injection	2/16/95
402C1	0.97	433	342		CoC testing (max. comb. temp, min. ESP power)	3/27/92
404C1	0.98	499	513		CoC testing (max. comb. temp., min. ESP power)	11/1/92
319B2	1.01	NA	525	Nor	Diagnostic testing	8/23/93
204C3	1.06	596	518	B	CoC testing (baseline)	7/1/92

TABLE 3-2. CEMENT KILN PCDD/PCDF

EPA Cond ID	D/F TEQ ng/dscm	APCS Temp (°F)	Stack Temp (°F)	Summ Comments	Cond Descr	Cond Date
204C5	1.14	NA	435	Nor	"Normal" haz waste cond.	7/18/94
319C5	1.15	443	448	B, Cond. avg. only	Pre BIF testing (baseline)	12/1/90
NHW10	1.20		358	B, NHWBCK, Lehigh, Union Bridge, MD		
300C3	1.24	NA	390	Nor	"Normal" haz waste cond.	7/28/93
204C7	1.35	NA	445	RT	Eval. of low chlorine waste	7/18/94
323C9	1.60	410	NA	RT	Eval. of high chlorine, high APCD temp.	6/1/96
401C1	1.76	436	334		CoC testing (max. comb. temp., min. ESP power)	4/9/92
206C3	1.98	530	493		CoC testing (low APCD temp.)	8/1/92
204C6	2.18	NA	436	RT	Eval. of low sulfur fuel	7/18/94
319B9	2.70	NA	485	Nor	Normal PCDD/PCDF and PM testing	10/23/91
404C4	3.29	516	524		Trial burn (max. comb. temp, max production, high chlorir	1/17/95
322C1	3.72	538	449		CoC testing (max. prod. rate, comb. temp. APCD temp.)	8/1/92
403C1	3.79	494	449		CoC testing (max. comb. temp., min. ESP power)	10/1/92
204C51	3.90	580	485		CoC	9/13/96
304C2	4.53	NA	453		CoC testing (max. comb. temp.)	8/1/92
203C1	5.06	383	514	Incorrect APCD temp.	CoC testing (max. waste feed)	8/19/93
323C1	5.18	491	454		CoC testing (max. comb. temp., prod. rate, APCD temp.)	8/1/92
204C50	6.50	615	505		CoC	9/13/96
300C2	11.0	608	332		CoC testing (max. comb. temp.)	8/20/92
319C2	19.7	593	566		CoC testing (max. comb. temp.)	5/5/92
304C5	24.1	NA	529	Nor	CoC testing	9/29/94
335C1	30.4	718	544		CoC testing (max. waste feed)	6/1/92
305C3	49.2	741	468		CoC testing (max. feed)	8/20/92

Part 2. Short and/or in-line raw mill kilns

NHW4	0.00	226	B, NHWBCK, Short, RMC Lonestar, Davenport, CA
NHW2	0.01	220	B, NHWBCK, Short, Calaveras, Redding, CA
NHW1	0.01	183	B, NHWBCK, Short, Capital Aggregates, SanAntonio, TX
NHW3	0.04	221	B, NHWBCK, Short, ILRM on, Ash Grove, Seattle, WA

TABLE 3-2. CEMENT KILN PCDD/PCDF

EPA Cond ID	D/F TEQ ng/dscm	APCS Temp (°F)	Stack Temp (°F)	Summ Comments	Cond Descr	Cond Date
NHW6	0.05		299	B, NHWBCK, BPM, Short, Capital Aggregate, SanAntonio, TX		
NHW5	0.21		233	B, NHWBCK, Short, Calaveras, Redding, CA		
202C3	0.06	NA	297	ILRM (off), 2 runs	PCDD/PCDF testing	4/1/94
202C4	0.06	NA	239	ILRM (on), 2 runs	PCDD/PCDF testing	4/1/94
303C9	0.01	180\420	222	Short, N, ILRM (off), CMBM	CoC testing (normal conditions)	12/1/95
303C5	0.01	NA	233	Short, B, ILRM (on), CMBM	Diagnostic testing (baseline)	10/31/93
303C8	0.01	190\430	226	Short, ILRM (on), CMBM	CoC testing (low comb. temp.)	12/1/95
303C4	0.01	NA	250	Short, ILRM (on), CMBM	Diagnostic testing (max. oper. temp)	10/21/93
303C7	0.78	355\441	348	Short, ILRM (off), CMBM	CoC testing (high comb temp.)	12/1/95
321C3	0.01	NA	225	Short, ILRM (off), B, 1 run	Baseline	10/13/93
321C4	0.01	NA	226	Short, ILRM (on), Nor, 2 runs	"Normal" haz waste cond.	10/13/93
321C3	0.01	NA	376	Short, ILRM (off), BPM, B, 2 runs	Baseline	10/13/93
321C4	0.02	NA	369	Short, ILRM (on), BPM, Nor, 2 runs	"Normal" haz waste cond.	10/13/93

Part 3. No longer burning hazardous waste

315C6	0.02	NA	243	Short, ILRM (off), B, NLBHW	CoC testing (baseline)	4/16/91
315C2	0.03	404	287	Short, ILRM (on), NLBHW	CoC testing (max. metals, chlorine, comb. temp)	7/15/92
315C1	0.04	341	281	Short, ILRM, NLBHW	CoC testing (max. metals, chlorine, comb. temp)	7/15/92
316C2	0.04	490\505	400	Short, NLBHW, CMBM	CoC testing (reduced metals feed)	3/25/92
315C5	0.06	NA	350	Short, ILRM (on), BPM, NLBHW	CoC testing	4/16/91
315C6	0.10	NA	358	Short, ILRM (off), BPM, B, NLRHW	CoC testing (baseline)	4/16/91
315C5	0.11	NA	247	Short, ILRM (on), NLBHW	CoC testing	4/16/91
315C4	0.12	NA	249	Short, ILRM (on), NLBHW	CoC testing	4/16/91
405C1	0.15	257	233	Short, NLBHW, CMBM	CoC testing (max. comb. temp., min. ESP power)	8/1/92
315C2	0.25	567	346	Short, ILRM (on), BPM, NLBHW	CoC testing (max. metals, chlorine, comb. temp)	7/15/92
315C1	0.30	551	346	Short, ILRM (on), BPM, NLBHW	CoC testing (max. metals, chlorine, comb. temp)	7/15/92
406C1	0.44	353\700	381	Short, NLBHW, CMBM	CoC testing (max. comb. temp., min. ESP power)	8/1/92

TABLE 3-2. CEMENT KILN PCDD/PCDF

EPA Cond ID	D/F TEQ ng/dscm	APCS Temp (°F)	Stack Temp (°F)	Summ Comments	Cond Descr	Cond Date
315C4	0.53	NA	376	Short, ILRM (on), BPM, NLBHW	CoC testing	4/16/91
316C1	0.58	510\505	421	Short, NLBHW, CMBM	CoC testing (max. waste feed)	3/25/92
317C2	1.12	515\230	316	Short, ILRM (on), NLBHW	CoC testing (min. FF pressure drop)	1/22/93
317C3	1.32	505\260	313	Short, ILRM (on), B, NLBHW, 1 run	CoC testing (baseline)	1/22/93
406C3	1.49	353\736	365	Short, NLBHW, CMBM	Trial burn (min. comb. temp., max. chlorine feed)	8/1/95
406C4	3.92	350\721	374	Short, NLBHW, CMBM	Trial burn (max. comb. temp., min. ESP power)	8/1/95
306C1	0.05	547	395	NLBHW	CoC testing (max. prod. rate and max. temp.)	5/1/93
309C50	4.53	487	425	NLBHW	CoC testing	7/1/96
309C4	12.7	NA	NA	Cond. avg. only, NLBHW	Reduced APCD temp.	8/1/94
309C50	17.7	502	425	NLBHW	CoC testing	7/1/96
309C5	33.5	NA	NA	Cond. avg. only, NLBHW	Reduced APCD temp.	8/1/94
309C1	49.9	642	490	NLBHW	CoC testing (max. comb. temp., waste feed)	10/1/92
Part 4. Conditions that are not adequate for MACT purposes (incomplete measurements or insufficient runs)						
406C5	0.00	740	NA	Short, NLBHW, 1 run, ICM	Pre BIF testing	11/1/90
406C5	0.00	740	NA	Short, BPM, NLBHW, 1 run, ICM	Pre BIF testing	11/1/90
406C7	0.00	740	NA	Short, NLBHW, 1 run, ICM	Pre BIF testing	11/1/90
406C6	0.00	720	NA	Short, B, NLBHW, 1 run, ICM	Pre BIF testing (baseline)	11/1/90
406C6	0.00	720	NA	Short, BPM, B, NLBHW, 1 run, ICM	Pre BIF testing (baseline)	11/1/90
406C7	0.00	740	NA	Short, BPM, NLBHW, 1 run, ICM	Pre BIF testing	11/1/90
323C4	0.03	358	NA	RT, 2 runs	Eval. of sodium carbonate addition	11/1/94
323C2	0.04	353	NA	B, 2 runs	PCDD/PCDF eval. (baseline)	11/1/94
323C3	0.04	355	NA	RT, 2 runs	Eval. of urea addition	11/1/94
323C5	0.04	357	NA	RT, 2 runs	Eval. of gypsum addition	11/1/94
206C4	0.04	450	418	B, 2 runs	CoC testing (baseline)	8/1/92
322C9	0.06	360	319	2 runs	CoC testing	11/1/95
323B4	0.07	392	364	2 runs	CoC testing (min. temp.)	11/1/95

TABLE 3-2. CEMENT KILN PCDD/PCDF

EPA Cond ID	D/F TEQ ng/dscm	APCS Temp (°F)	Stack Temp (°F)	Summ Comments	Cond Descr	Cond Date
322C4	0.08	NA	372	B, 2 runs	Baseline testing	8/9/93
204C8	0.08	NA	398	1 run only	Eval. of water injection	7/18/94
404B1	0.12	385	NA	RT, 2 runs	Eval. of low APCD temp.	5/19/95
323C6	0.12	360	NA	RT, 2 runs	Eval. of low APCD temp.	11/1/94
322C2	0.17	395	NA	2 runs	CoC testing	11/1/94
228C5	0.21	395	NA	RT, 2 runs	Eval. of PCDD/PCDF control	11/18/93
404C9	0.34	472	NA	RT, 2 runs	Eval. of high APCD temp.	5/19/95
335C3	0.42	NA	340	B, 2 runs	Baseline testing	9/19/94
404C5	0.49	NA	459	2 runs	Trial burn (PM evaluation)	1/17/95
323C7	0.53	400	NA	RT, 2 runs	Eval. of high APCD temp.	11/1/94
335C2	0.59	NA	325	B (tires/coal), 2 runs	Baseline testing	6/17/94
335C4	1.02	NA	336	Nor, 2 runs	"Normal" haz waste cond.	9/19/94
322C6	1.17	NA	378	2 runs	Eval. of low APCD temp.	8/9/93
322C5	4.39	NA	403	Nor, 2 runs	"Normal" haz waste cond.	8/9/93
319C7	5.82	475	511	B, 1 run	Pre BIF testing (baseline)	12/1/90
319C6	7.54	527	545	2 runs	Pre BIF testing (normal cond.)	12/1/90
322C7	7.61	NA	418	1 run	Eval. of potash addition	8/9/93

TABLE 3-3. PCDD/PCDF STACK GAS AND RAW MATERIALS LEVELS
FROM CEMENT KILNS

Kiln No	Cond. No.	Stack Gas Emissions		Raw Feed Input		Emissions/Feed	
		Cond Avg (µg/sec)		Daily Composite (µg/sec)		Total	TEQ
		Total	TEQ	Total	TEQ		
A	1	4.10E+00	6.90E-02	1.20E+01	1.29E-01	0.342	0.535
A	2	5.99E-02	6.76E-04	1.00E+01	1.51E-01	0.006	0.004
A	3	4.05E-02	5.20E-04	1.40E+01	1.92E-01	0.003	0.003
B	1	1.77E+01	2.22E-01	8.73E-01	2.82E-03	20.275	78.723
B	2	2.71E+01	3.56E-01	1.58E+00	6.55E-03	17.152	54.351
C	1	3.60E-01	4.20E-03	1.70E-01	1.01E-03	2.118	4.158
D	1	1.91E-02	1.11E-04	4.70E-01	nd	0.041	
D	2	5.92E-03	3.77E-05	3.71E-01	nd	0.016	
E	1	1.50E+01	1.01E-01	5.70E+00	7.40E-03	2.632	13.649

A-1 : High kiln outlet temperature

A-2 : Low kiln outlet temperature

A-3 : Normal test condition

Adapted from:

D.L. Constans, "Sources of PCDDs/PCDFs in Cement Kiln Emissions," *Proceedings of the 1996 Incineration Conference* , Savannah, GA, May 1996, pp. 703-705.

HWC MACT May 1997 NODA Comment Response DCN CS4A-00033.

TABLE 3-4. LWAK PCDD/PCDF

EPA Cond ID	APCS	APCD Temp (°F)	D/F TEQ ng/dscm	Cond Date	No. Runs	Summ Comments	Cond Descr		
							Normal Mode	Baseline Mode	Permit Mode
336C2	FF	400	0.03	3/24/94	1	PCDD/F eval.	No	No	x
336C1	FF	400	0.04	3/24/94	2	PCDD/F eval.	No	No	x
314C50	FF	417	0.25	11/1/96	3	PCDD/F eval., compliance test	No	No	x
226C51	FF	375	0.5	7/1/97	3	Water quench eval., EPA/EER test	No	No	
226C50	FF	400	1.7	11/1/96	3	PCDD/F eval., EPA/EER test	Yes	No	

TABLE 3-5. LWAK PM APCD AND STACK GAS TEMPERATURES

EPA Site ID	APCD Temperature (°F)				Stack Temperature (°F) Avg
	Cond Avg		Run Avg		
	Max	Min	Max	Min	
223	411	411	413	407	293
224	399	383	400	356	313
225	410	398	416	398	302
226	422	419	427	412	320
227	385	385	406	351	364
307	443	427	443	417	136
310	342	325	349	324	314
311	412	412	423	401	346
312	425	425	426	424	348
313	419	419	420	419	342
314	437	420	443	415	347
336	400	400	400	400	340
474	408	408	411	405	318
475	404	404	407	402	358
476	431	431	431	431	327
479					140
608	432	432	434	430	354

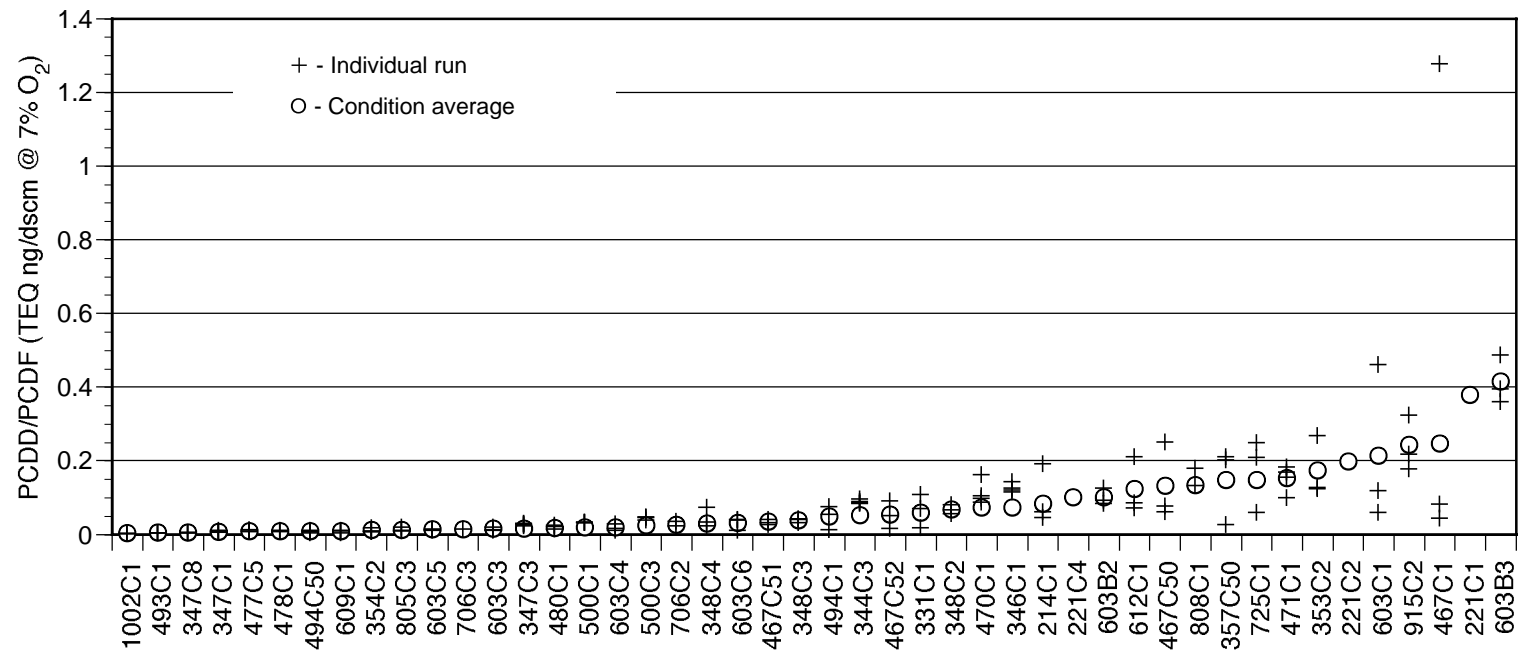


Figure 3-1. PCDD/PCDF emissions from “other” incinerators with PM APCD temperature < 400°F.

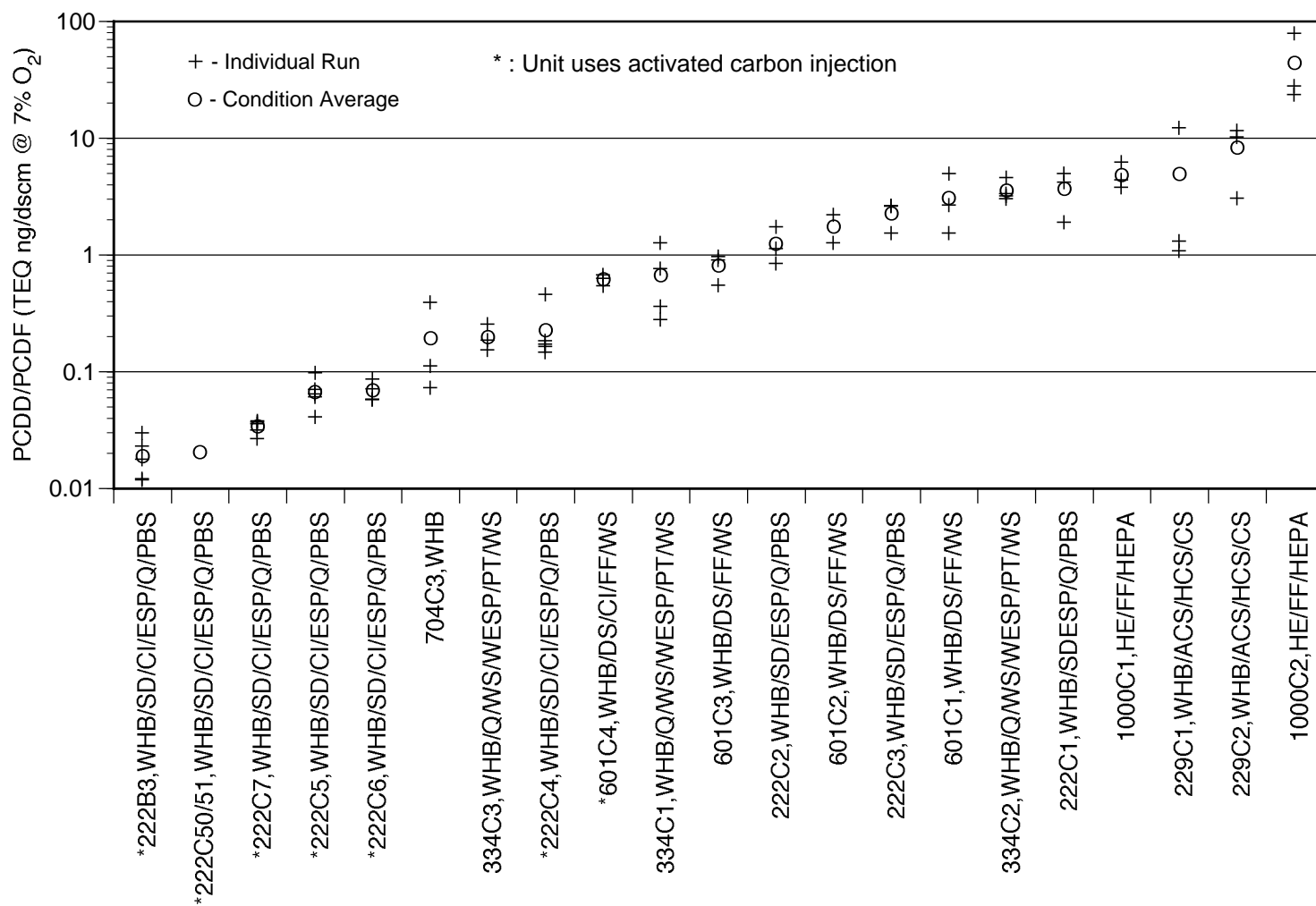


Figure 3-2. PCDD/PCDF TEQ emissions from incinerators with waste heat boilers.

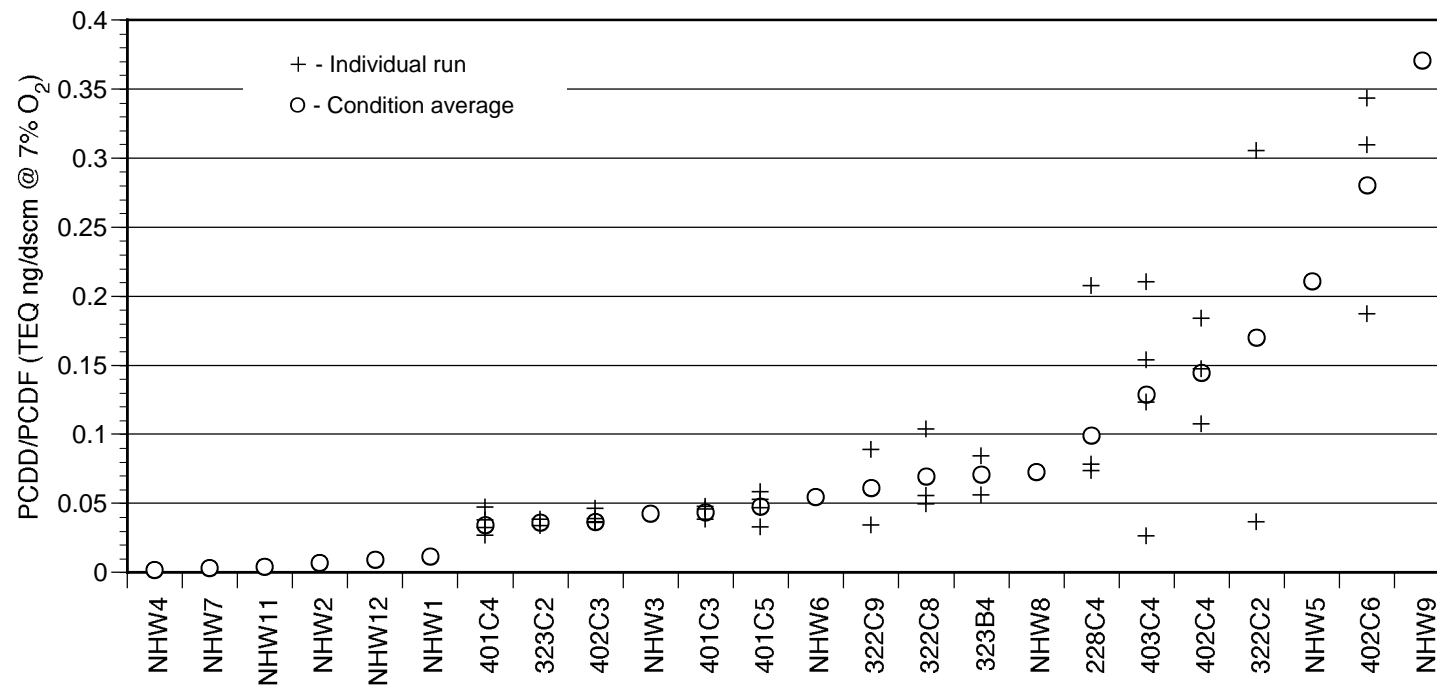


Figure 3-3. PCDD/PCDF emissions from long, non in-line raw mill cement kilns with PM APCD temperature < 400°F.

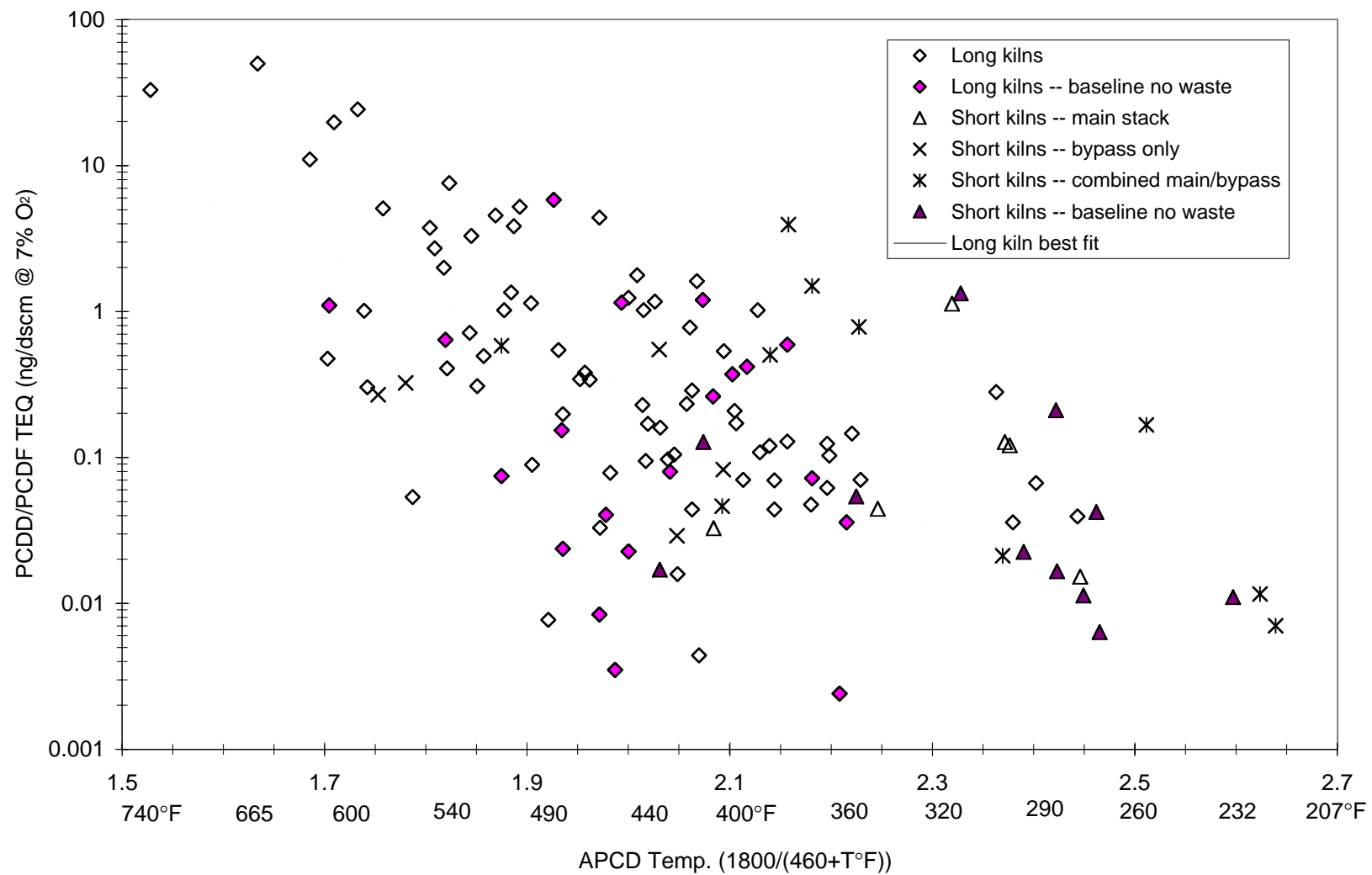


Figure 3-4. PCDD/PCDF TEQ emissions as a function of APCD temperature for all cement kilns.

CHAPTER 4

PARTICULATE MATTER

The particulate matter (PM) standard serves as a surrogate control for emissions of the non-enumerated HAP metals of antimony, cobalt, manganese, nickel, and selenium. Chapter 12 of this document discusses the rationale for the use of PM as a surrogate for these metals.

All existing hazardous waste combustors are currently subject to a federal EPA PM standard of 0.08 gr/dscf @ 7% O₂ (incinerators under RCRA incinerator regulations, and cement and lightweight aggregate kilns under the RCRA BIF regulations).

The PM MACT floor procedure involves, as discussed in Chapter 2: (1) defining MACT control based on the PM control equipment used by the best performing sources; and (2) identifying an emissions level that well-designed, operated, and maintained MACT controls are achieving based on demonstrated performance of existing HWCs.

4.1 INCINERATORS

Table 4-1 summarizes all particulate matter (PM) test condition data from HWIs, ranked by condition average. The data are from about 75 different incinerators. Trial burn condition averages range widely from 0.0002 up to (and over in a couple of cases) the current RCRA standard of 0.08 gr/dscf. The table is divided into three different sections: (1) sources appearing to use MACT floor control of ESP, FF, or IWS; (2) sources not using MACT floor control; and (3) sources no longer burning hazardous wastes.

PM emissions levels from HWIs are dependent on: (1) the “uncontrolled” PM level and particle size distribution, which are affected by factors such as incinerator type and design, PM entrainment rate, and waste composition (including waste ash content, waste sooting potential, waste chlorine, etc.); and (2) PM APCD type and design. PM add-on APCD systems used by existing HWIs include:

- Systems with “dry” collection devices including fabric filters (FF) and electrostatic precipitators (ESP).
- Systems with “wet” collection devices including:
 - Conventional medium and high-energy wet scrubbers (venturi types (VS)) which are used on many liquid injection (low ash) facilities.
 - Novel wet scrubbers including hydrosonic, free-jet, and collision-type scrubber designs.
 - Wet electrostatic precipitators (WESP) and ionizing wet scrubbers (IWS).
- Systems with conventional low energy packed bed and spray type tower scrubbers designed primarily for acid gas control. Although they are also effective at PM removal to some degree.
- Systems with combinations of both “dry” and “wet” devices in series (e.g., VS/IWS, SD/FF/IWS, SD/ESP/WS, etc.).
- Sources which have no active add-on APCD, relying instead on waste ash feed rate control. Some facilities meet the current regulatory standards based solely on treating waste with low ash content.

4.1.1 Existing Sources Floor

As seen in Table 4-1, the best-performing HWI sources generally utilize either fabric filters, electrostatic precipitators (dry and wet), or ionizing wet scrubbers (sometimes in combination with venturi scrubbers or packed bed or spray tower scrubbers). Certain wet scrubbing techniques such as high energy venturis and novel wet scrubbers (such as condensation, free-jet, and collision designs) can also perform well, achieving emissions levels less than 0.005 gr/dscf in many cases. However, in general, FF, ESP, and IWS provide superior PM control performance. These type of controls make up the bulk of the average of the best performing 12% of sources. Thus, MACT for existing sources is defined as the use of either FF, ESP, or IWS.

Note also that there are facilities using medium and low energy wet scrubbers that are achieving low PM levels. Generally though, these sources are liquid incinerators treating wastes with low ash content. These add-on APCDs are not considered as MACT, due to these atypical (or at least not generally applicable) operating conditions.

The incinerator PM MACT floor is set at 0.015 gr/dscf as EPA's best engineering judgement of a level achievable in practice while using MACT floor control. This level is based on a variety of considerations. These are discussed in the following subsections.

Evaluation of HWI Trial Burn Data Set

Various characteristics of the HWI PM trial burn data include:

- 26 different incinerator sources are using MACT floor control and meeting the floor level of 0.015 gr/dscf. Of the total of 109 incinerators for which trial burn emissions data are available, 24% (26 of 109 units) are using MACT floor controls.
- An emissions level of 0.015 gr/dscf is being achieved on a continuous basis by sources using a well designed and properly operated FF, ESP, or multiple-stage IWS:
 - Fabric filters with conventional woven fiberglass bags have demonstrated emissions control levels on HWIs, municipal waste combustors (MWC), and medical waste incinerators (MWI) below 0.010 gr/dscf. With improved fiberglass or Nomex felt and tri-loft fabrics, levels lower than 0.005 gr/dscf have been demonstrated. High performance membrane fabrics (such as Teflon and Gore-tex™), have demonstrated levels below 0.0010 gr/dscf over long term operation (for example, see Feldt, 1995). With the use of an optimal fabric cleaning cycle, regular bag replacement and routine maintenance schedule, PM emissions levels below 0.015 gr/dscf are being achieved on a continuous basis with many different types of fabrics.

Numerous currently operating HWIs utilize these fabric types to consistently achieve PM levels below 0.015 gr/dscf. For example: Source ID Nos. 337, 351, 503, 727, and 1001 use Nomex (and other heavy) felt bags; ID No. 341 uses polyacryl felt bags; ID Nos. 210, 211, 212, 325, 327, 333, 601, and 612 use Teflon-coated fiberglass bags; and ID Nos. 349 and 359 use Gore-tex™ bags. Note that ID No. 359 has some conditions with PM levels above 0.015 gr/dscf.

However, as discussed below, these are likely due to salt carryover entrainment from a poorly operated wet scrubber located downstream of the FF and are not considered a direct indicator of the FF performance capabilities.

-- As demonstrated, well designed and operated ESPs are achieving levels less than 0.010 gr/dscf on a routine basis on HWI and MWCs, and levels less than 0.005 in many cases. “Well designed” can include those systems with:

- Specific collection areas greater than 500 ft²/kacfm.
- Advanced power system controls. For example, the use of microprocessor controls as opposed to old analog controls, and the use of intermittent energization or pulse energization techniques.
- Optimized rapping cycle and frequency.
- Proper internal plate and electrode geometry to allow for high voltage potentials.
- Flue gas conditioning. For example, the addition of water or reagents such as sulfur trioxide or ammonia to condition particulate matter for lower resistivity.
- Multiple “sectionalization” of ESP fields.
- Optimized design, including proper gas distribution within the ESP, reduced air infiltration, system grounding, etc.

Examples of well designed, and properly operated ESPs at existing HWIs include Source ID Nos. 222 and 340. Both are consistently achieving levels less than 0.015 gr/dscf.

-- Well designed and operated IWSs, used on existing HWI facilities such as ID Nos. 603, 600, 348, and 331, are achieving levels less than 0.015 gr/dscf.

- The 0.015 gr/dscf level is currently being achieved by many HWI facilities using different types of high performance wet scrubbers that are not specifically designated as MACT, including high energy collision, free jet, and venturi unit types.
- Facilities that are meeting the 0.015 gr/dscf floor level are also generally achieving SVM SREs greater than 99% and LVM SREs greater than 99.9%. This is consistent with expected SREs from engineering judgment based on the capture of fine and medium-sized particulate matter containing these metals.
- Facilities with a range of designs and waste types are meeting the 0.015 gr/dscf level, including those with high PM entrainment rates (such as fluidized bed and rotary kilns, Source ID Nos. 222, 325, etc.) and those with wastes that generate difficult-to-capture fine particulate matter (such as certain liquid injection facilities).
- Over 50% of all existing unit test conditions, regardless of the type of APCD employed, are currently meeting a level of 0.015 gr/dscf.
- Some facilities with wet scrubbers have upgraded or are in the process of upgrading existing APCS to meet a PM level of less than 0.015 gr/dscf:
 - Source ID No. 339 (DuPont, NJ) added an electro-dynamic venturi (EDV) APCD to an existing venturi scrubber-based system and achieved PM levels of less than 0.010 gr/dscf (Hinshaw and Vickery, 1997).
 - Source ID No. 216 (Rollins, NJ) has pilot-tested two wet ESPs and rotary-agglomeration EDV scrubber on a slip stream of flue gas at their hazardous waste incinerator (Ullrich and Waked, 1996). The two wet ESPs consistently achieve levels of less than 0.005 gr/dscf. The rotary scrubber achieves levels of less than 0.010 gr/dscf.
- PM levels from many systems may be greater than 0.015 gr/dscf due to particulate salt entrainment and carryover from poorly designed and operated wet scrubbers located downstream of the primary PM APCD. This finding is supported by recent work at the Rollins, NJ HWI, which has shown that the PM exiting the APCS is comprised of 60% (by weight) salts. Improving wet scrubber demister design and operation and/or reducing suspended and dissolved solids content in the scrubber liquor (achieved, for example, by

increasing the level of fresh make-up water) are simple and cost-effective ways to reduce the PM below the 0.015 gr/dscf for many existing systems.

Air Pollution Control Device Vendor Survey

The 0.015 gr/dscf level is well within the accepted capabilities of conventional air pollution control systems used by existing HWIs. Air pollution control device vendor guarantees on standard equipment are below 0.015 gr/dscf, with some as low as 0.005 gr/dscf. This is based on recent discussions with APCD vendors, including those supplying IWSs, FFs, ESPs, wet ESPs, and wet scrubbers (such as collision, free-jet, and other high-pressure drop venturi types). This is consistent with A.J. Buonicore (1992), who reports in a review of the hazardous waste incinerator industry that typical vendor guarantees for FF, ESP, and IWSs are below 30 mg/dscm.

Also, a recent presentation by an on-site incinerator and wet ESP vendor indicates that performance guarantees for meeting the PM level of 0.015 gr/dscf are being provided for a wet ESP retrofit to 3 hazardous waste incinerators (Knisley et al., 1999)). The same vendor has also provided similar performance guarantees for various other types of incinerators (including medical, sewage sludge, etc.) (EER, 1999).

Another on-site incinerator had been recently given a performance guarantee to meet PM MACT using a new "EDV" collector (a combination of venturi and ESP characteristics). Testing indicated it was not consistently meeting the levels. The vendor is taking back the EDV and supplying a new wet ESP (with same guarantee) at a bargain price.

Finally, note that MWC and MWIs have been given PM performance guarantees of less than 0.015 gr/dscf as a result of recent standards.

Medical and Municipal Waste Combustors Standards and Experience

The 0.015 gr/dscf level is consistent with recently finalized PM emissions standards for medical waste incinerators (MWI) and municipal waste combustors (MWC). Specifically:

- MWI -- Medical waste incinerator emissions guidelines for existing incinerators and New Source Performance Standards for new sources have recently been finalized. Use of a FF is the basis of the PM standard of 34 mg/dscm for existing large-sized, new large-sized, and new medium-sized facilities. Use of a venturi scrubber is the basis of the PM standard of 70 mg/dscm for existing medium and new small-sized units. The standards are based on

a compilation of PM emissions data from many existing MWIs with FF and VSs. These include data from two separate large MWIs with conventional FFs showing less than 2 mg/dscm (Von Remmen, 1998) and 10 mg/dscm (Maziuk, 1996) and from a medium MWI with a high temperature FF showing less than 20 mg/dscm PM emissions (Hogan, 1997).

- MWC -- The municipal waste combustor PM MACT standard of 27 mg/dscm for existing large sources is based on the use of FF. Like MWIs, the standard is based on a large compilation of PM emissions data from many existing MWCs with FF and ESPs (e.g., see U.S. EPA, 1989). Heap (1998) reports PM emissions less than 14 mg/dscm on a recently upgraded MWC facility.

Comparison of the HWI PM standard to these other waste combustors is appropriate because in many cases the PM characteristics, such as size distribution, loading, and PM type, are comparable within the three different types of waste burning classes.

Coal Combustor Experience and Standards

EPA New Source Performance Standards for coal combustors (utility, industrial, and commercial boilers) for PM range from 32 to 90 mg/dscm, depending on boiler start-up date, type, and size. PM emissions from coal fired boilers with FF are reported to range from 5 to 30 mg/dscm from those using efficient cleaning procedures (Cushing, Merritt, and Chang, 1990). FF specific collection areas ranged from about 1.5-2.5 ft²/acfm. These levels are also achievable with high efficiency ESPs.

European Experience and Standards

Select European hazardous waste incinerator PM standards include the following, which must be complied with using a PM CEM:

- Germany -- PM standards of 42 mg/dscm (on half-hour standard) and 14 mg/dscm (on 24-hour standard), under the Seventeenth Ordinance on the Implementation of the Federal Emission Control Act in Germany (Ordinance on Incineration for Waste and Similar Combustible Material, referred to as 17.BImSchV issued in 1990) (Hartenstein et al., 1997).
- Netherlands -- PM standards of 7 mg/dscm (Morris and Waldheim, 1998)

- European Union -- PM standards of 14 (on half-hour standard) and 7 mg/dscm (on 24-hour standard) under the more recent 1994 European Union Council Directive on the Incineration of Hazardous Waste (Piechura and Zeeb, 1996; Hartenstein et al., 1997; Van Remmen, 1999).

TUV - Rheinland has been the recognized worldwide authority on PM CEMS (referred to as “dust monitors” in Europe) for the past 3 decades. This organization is responsible for the initial engineering development and implementation of PM CEMS technologies and most of their ongoing certifications in Germany. Recent discussion with TUV indicate that most German incinerators normally have no problems operating at PM levels less than 14 mg/dscm (EPA/EER communication with Dr. Jockel, 1998). In fact, recent advances in emission control practices and emission regulations there has created a need for a more sensitive reference method and a PM CEMS able to accurately measure PM levels less than 1 mg/dscm. In 1997 TUV certified a PM CEMS manufactured by Sigrist, a Swiss company, across a waste incinerators normal operation and emissions of less than 0.06 to 0.20 mg/dscm (TUV-Rheinland, 1997).

They further note that PM CEMS have not only been used for monitoring compliance, but also used as an effective means for achieving compliance. Just as CO and HC CEMS have become the common tool for maintaining optimum combustion conditions, PM CEMS are likewise used as a tool to better define what process and APCD conditions affect PM emissions and how to reduce emissions. Facilities are given about 3 years to use their PM CEMS as a means for evaluating their APCD performance and achieving compliance. The PM CEMS also served as a check on the status and progress of their efforts and showed which operating styles were the most emission-effective. And likewise, APCD vendors have benefitted from the new level of information produced by PM CEMS (EPA/EER communication with Dr. Jockel, 1998). Apparently, this approach of using PM CEMS is so effective that it has lead to dramatic improvement in emission control practices, as evidenced by achieving PM emissions levels of less than 1 mg/dscm.

Pilot Scale Fabric Filter Performance

Pilot- and lab-scale FF demonstrations of PM control performance using various fabric types, all of which are used on currently operating HWIs as discussed above, further confirm the achievable PM level of 0.015 gr/dscf. See Table 4-2. PM levels of less than 30 mg/dscm have been demonstrated by many different types of fabrics (e.g., see Davis et al., 1990; Klimezak, 1988; EER, 1994). Note that these tests were performed with relatively high inlet PM grain loadings (greater than 10 gr/dscf) and small-sized PM (0.5 μ m in diameter), which make these

tests representative of uncontrolled PM emissions from worst-case HWIs (such as rotary kilns and fluidized bed incinerators).

Selected Technical Articles on PM Performance at Incinerators

Gablinger and Sigg (1998) report that four waste burning facilities, each with different air pollution control system configurations, can meet the European incinerator PM standard (as well as all other emissions standards at the same time). They then conclude that they can easily meet the EPA HWC MACT PM standard of 34 mg/dscm (and others as well). These systems include:

- WTI, a U.S. HWI, which uses an ESP and PBS, and has PM emissions of less than 10 mg/dscm. This facility's performance is especially significant because multiple source testing PM evaluations have been performed over the last couple of years as a result of trial burn and quarterly emissions testing requirements.
- A European solid waste burning HWI with an ESP has PM levels of less than 3 mg/dscm.
- A liquid injection HWI and a sewage sludge incinerator, both using venturi-type wet scrubbers, have PM levels less than 30 mg/dscm.

Ullrich and Mehta (1997) report that two U.S. commercial HWIs with FFs have PM less than 2 mg/dscm and will "have no difficulty meeting the MACT PM standard" (of 34 mg/dscm). Mekari (1997) reported similar results with PM emissions less than 7 mg/dscm at a HWI controlled with a high temperature FF and venturi scrubber. Ullrich and Waked (1996) also report that pilot scale work has shown that wet ESPs may be added to existing facilities with existing "wet" APCDs and will effectively reduce PM emissions to less than 10 mg/dscm; the addition of "Hydrop" scrubbers will reduce PM emissions to 30 mg/dscm. Others report on the effective use of wet ESPs on HWIs to meet the MACT floor PM levels:

- Piechura and Zeeb (1996) report on a German HWI with a wet ESP achieving PM levels of less than 1 mg/dscm.
- Meier (1995) reports on various HWIs using wet ESPs and achieving PM levels of less than 5 mg/dscm.

- Young et al. (1998) and Booth et al. (1997) report on HWI treating chemical agent and munitions wastes using conventional venturi scrubbing achieving PM levels averaging 5 and 20 mg/dscm, respectively.
- Hinshaw and Vickery (1997) report that the use of an “electrodynamic venturi” at a U.S. HWI reduced PM to consistently less than 30 mg/dscm.

PM performance from FFs with Gore-tex™ (polytetrafluoroethylene) membrane bags have been reported from many types of different combustion systems. PM levels of less than 10 mg/dscm, with many less than 2 mg/dscm, have been achieved on various combustion sources, as reported in Gore product literature. These include: many U.S. and European HWIs (e.g., Sullivan and Pfeffer, 1993; Feldt, 1991); U.S. and European municipal waste combustors (Brinckman, 1993; Cipriani and Pranghofer, 1996); medical waste incinerators (Avina and Esposito, 1993); soil thermal remediation systems; cement kilns; and tire incinerators (Brinckman, 1992).

Also, PM performance levels from 2 to 20 mg/dscm on various mobile Superfund Site incinerators using FF and wet scrubbers are summarized in Chapter 12, Table 12-10, taken from various papers reported at various recent Incineration Conferences.

Air Pollution Control Textbook and Handbooks

Typical APCD performance curves as a function of PM size and system design (e.g., venturi pressure drop, fabric type, ESP plate area, etc.) can be found in various air pollution control device literature and handbooks. These demonstrate that a conventionally designed venturi scrubber, FF, and ESP can achieve greater than 99% control of PM, and in many cases greater than 99.9% control, depending again on the system design and PM characteristics. These performance curves are used to make projections of emissions assuming some given APCD performance (based on system design) and PM inlet loading and size distribution. For example, with a inlet grain loading of 10 gr/dscf (at the upper end for typical solid waste kiln), an overall collection efficiency of 99.9% would be required to achieve a PM emissions level of 0.01 gr/dscf (20 mg/dscm). This efficiency is achievable with conventionally designed venturi scrubbers, ESPs, and FFs.

EPA Peer Review

EPA MACT HWC peer reviewers unanimously concluded that a PM level of 35 mg/dscm was achievable by HWIs with the use of well designed, maintained, and operated FF or ESP (based on among other things, an evaluation of HWI trial burn data).

Evaluation of Test Conditions Appearing to Use MACT But Not Meeting Floor Level

Figure 4-1 shows PM emissions data from HWI facilities that appear to be using the MACT control technology (FF, IWS, or ESPs). The majority are less than 0.015 gr/dscf. About 25% of these conditions appear to be using MACT but are not achieving the floor level of 0.015 gr/dscf. These test conditions are from 16 different incinerators including:

- 4 systems using FFs (2 with FF only and 2 in combination with wet scrubbing).
- 5 systems using IWSs (3 with IWS only and 2 in combination with venturi or packed tower scrubbers).
- 7 systems using wet ESPs (all used in combination with venturi or packed tower scrubbers).

There are numerous factors that impact the level achievable by MACT control. These include equipment design, operation, and maintenance practices, and stack gas sampling method accuracy. Given the data and information available, it is difficult to precisely identify the design, operating, or maintenance factors responsible for a source not achieving a 0.015 gr/dscf PM level while apparently employing MACT control. Nonetheless, these test conditions are not considered representative of MACT control. They include:

- Source ID Nos. 503, 727, and 1001 are Department of Defense conventional munitions incinerators (Lake City, Iowa Army, and Tooele Ammunitions Plants, respectively). All use FFs with Nomex felt and A/C ratios of about 5:1. Source ID No. 1001 has 6 test conditions -- three with PM less than 0.015, one at 0.02, and one at 0.06 gr/dscf. Source ID No. 503 has six test conditions with PM ranging from 0.015 to 0.03 gr/dscf. Source ID No. 727 has two test conditions, one with a PM level less than 0.01 gr/dscf, and the other with PM greater than 0.10 gr/dscf (higher than the current RCRA standard).

The MACT floor PM level of 0.015 gr/dscf is achievable with both FFs with Nomex bags (and venturi scrubber units) on conventional (and chemical) munitions incinerators:

- All three of the units have individual test conditions with PM less than 0.015 gr/dscf.
- The marginal and erratic performance at the Tooele unit FF, and the sub-standard performance of the Lake City unit FF, may be due to high air-to-cloth ratio design and poor operating and maintenance practices (evidenced also by mediocre SVM SREs).
- Levels of less than 0.015 gr/dscf have been demonstrated with Nomex equipped FFs in other hazardous waste incinerators (e.g., Nos. 333 and 337) and in various pilot scale filter efficiency tests, as discussed above. Improved system operation and/or upgrade to a high efficiency fabric type such as heavier felt bag, or bag coated with teflon or membranes, is projected to result in PM emissions less than 0.01 gr/dscf.
- One conventional munitions burning unit with an unknown APCD (McAlestar OK Unit) has PM less than 0.005 gr/dscf (as reported to EPA by DoD). Also, an Iowa Army Ammunition unit (Source ID No. 351) has PM less than 0.01 gr/dscf. Two units with VSs burning chemical agent munitions -- Tooele and Johnston Atoll (Nos. 346 and 347) -- have PM emissions less than 0.01 gr/dscf.
- Source ID No. 212, with one test condition PM level of about 0.025 gr/dscf, uses a FF with a Teflon bag material and an A/C ratio of 4.5. Wet scrubbing is also used downstream of the FF. However, this performance is not indicative of MACT control since:
 - Two other kilns at the same site (Source ID Nos. 210 and 211) using identical APCDs are achieving PM levels less than 0.015 gr/dscf.
 - As discussed above, particulate salt entrainment and carryover from a poorly designed and operated wet scrubber located downstream of the FF may be responsible for PM levels greater than 0.015 gr/dscf.

- As discussed above, FFs with Teflon fabric are able to achieve levels less than 0.015 gr/dscf with proper design, maintenance, and operation.
- Source ID No. 359 is configured with a FF using Gore-tex™ fabric at an A/C ratio of 4.5, and is followed downstream by a wet scrubber. Under three test conditions it produced PM emissions levels greater than 0.015 gr/dscf. However, this performance is not indicative of MACT control since:
 - Within each of these test conditions, two of the three individual runs are less than 0.015 gr/dscf. The one high run appears to be an outlier.
 - This source has PM emissions levels from three other conditions that are much less than 0.015 gr/dscf. This performance level has been routinely demonstrated with the use of Gore-tex™ fabric material.
- Source ID No. 331 (Ross at Grafton, OH) uses a 4-stage IWS system. PM data from seven older conditions range from 0.03 to 0.08 gr/dscf. However, PM data from the three newer test conditions are much less than 0.015 gr/dscf. This is consistent with the source's claims to have reduced its PM level to consistently less than 0.008 gr/dscf over the past few years, based on supplemental information contained in the most recent trial burn report.
- Source ID No. 603 uses a 4-stage IWS. It has one test condition with a PM average of about 0.03 gr/dscf. However, within this test condition, there are four individual runs with PM less than 0.015 gr/dscf and one apparent outlier run greater than 0.08 gr/dscf. Additionally, this facility has 10 other test conditions with PM levels much less than 0.015 gr/dscf.
- Source ID No. 214 (Rollins at Baton Rouge, LA) uses a 3-stage IWS. It has one test condition with PM at 0.03 gr/dscf and one at 0.015 gr/dscf. To meet a level of 0.015 on a consistent basis, the facility reports that it will likely have to add an additional IWS stage (Ullrich and Mehta, 1997).
- Source ID No. 354 uses a VS and 2-stage IWS combination. It has one test condition with PM at 0.025 gr/dscf and three other test conditions at levels much less than 0.015 gr/dscf.

- Source ID No. 357 uses a VS and a 2-stage IWS combination. It has one test condition with PM at about 0.025 gr/dscf. It is in the process of upgrading its APCS to include additional IWS stages and/or a new wet ESP. Additionally, recent demonstration tests have shown PM emissions ranging from 0.005 to 0.009 gr/dscf (Humphreys et al., 1996). Recent source communications indicate that the facility will comply with the floor through waste feed control measures.

- Source ID Nos. 705, 825, 334, 708, 353, and 808 all use some combination of a wet ESP with additional packed bed and/or venturi scrubbing. All have conditions with PM emissions ranging from 0.02 to 0.06 gr/dscf. These levels are not considered representative of MACT control:
 - Some sources are using poorly designed wet ESPs with plate charging and collection area SCA of less than 150 ft² /kacfm. Source ID Nos. 705 and 454 are examples of these substandard ESPs. Note that Source ID No. 705's wet ESP is used as a "demister" downstream of wet scrubbing, and is not designed for primary PM control.

 - Source ID No. 825 has one test condition with individual PM runs of greater than 0.08 gr/dscf. However, it is acknowledged in the test report that the APCS had operational problems during the testing, and that the results are not representative of the facility PM performance.

 - Source ID Nos. 334 (3M, Minnesota) and 708 (Burroughs Wellcome, Greenville, NC) have performed APCS upgrades since the trial burn testing contained in the database. Recent PM testing data from ID No. 708 shows that a PM level of less than 0.01 gr/dscf is being achieved (Meier, 1995). ID No. 334 has conducted testing with the addition of a new EDV APCD. PM emissions of less than 0.005 gr/dscf have been demonstrated over a wide range of operating conditions (Pilney et al., 1993).

 - Source ID Nos. 808 and 353 have a single condition with PM of 0.03 to 0.04. However, they have other testing conditions with average PM levels much less than 0.015 gr/dscf.

- PM levels are sometimes inflated as a result of particulate salt entrainment and carryover from poorly designed and operated wet scrubbers located downstream of the MACT PM control equipment.

4.1.3 New Sources Floor

As for existing sources, MACT for new sources is defined as a well operated FF, ESP, or IWS. This is because these MACT controls are considered equivalent in performance; and the best controlled single source is using control methods similar to the best 6% of sources, as discussed above for existing sources. Thus, the floor for new sources is the same as the PM floor for existing sources -- 0.015 gr/dscf.

4.1.4 Alternative Floor for Incinerators

As discussed above, PM floor control is used as a surrogate control for non-enumerated metal emissions. PM control is also an integral part of the SVM and LVM emission standard, because when determining the semivolatile and low volatile metal floor standards, emissions were considered from only those facilities that were meeting the numerical particulate floor and using MACT floor control. The above determined floor level of 0.015 gr/dscf is appropriate for facilities burning wastes that are known to contain non mercury metals (i.e., SVMs, LVMs, and nonenumerated metals).

An alternative PM floor level of 0.030 gr/dscf is set for incinerators that are demonstrated to have “deminimis” levels of metals in the hazardous waste (and other) feedstreams. Note again that this does not include mercury (or other high volatile metals) which is not generally actively controlled through PM control. For these facilities which are using “superior” feedrate control of non-mercury metals, this alternative (higher) PM floor is appropriate because PM control is not as important for controlling non-mercury metals (i.e., because these metals are not being fed to the combustor). It is determined that an alternative floor control level of 0.030 gr/dscf is appropriate for these sources. This level continues to provide adequate particulate matter control to control the CAA metals that are present below detectable levels. It also allows for the use of less costly control methods in comparison to the 0.015 gr/dscf floor. As discussed below, the alternative floor of 0.030 gr/dscf is based on the use of less sophisticated baghouses and ESPs, and currently and frequently used high energy venturi scrubbers. As discussed in the companion *Technical Support Document Volume IV: Compliance With MACT Standards*, qualification for the alternative PM floor requires that the feedstreams contain deminimis levels of metals. This is done, in part, by showing that the feedstreams contain non-detectable levels of non-Hg CAA HAP metals.

Floor control for this alternative PM standard is based on the use of high energy venturi type wet scrubbers, as well as equivalent performing FF, IWS, and ESPs (which are somewhat less sophisticated in design and operation in comparison to those on which the above discussed floor level of 0.015 gr/dscf is based).

An alternative floor level of 0.030 gr/dscf is determined to be representative of well designed, operated, and maintained high energy wet scrubbing controls. This is based on a variety of considerations, including:

- The performance of these controls on existing hazardous waste incinerators. High energy wet scrubbers are used on many units, and meeting PM levels of less than 0.03 gr/dscf, as shown in Table 4-1, including:
 - Rotary kiln units -- Source ID Nos. 221, 488, 489, 609, 605, 346, 347, and 342 are consistently meeting levels of less than 0.015 gr/dscf. Source ID Nos. 613, 216, 486, 711, and 480 are meeting levels of less than 0.03 gr/dscf.
 - Liquid injection units -- Source ID Nos. 726, 344, 824, and 229 are meeting levels of less than 0.015 gr/dscf. Source ID No. 458 is meeting a level of less than 0.03 gr/dscf.
 - Fixed hearth and fluidized bed units -- Source ID Nos. 470, 700, and 504 are meeting levels of less than 0.03 gr/dscf.
- Established capabilities of these systems identified in the air pollution control literature. For example, A.J. Buonicore (1992) reports on vendor guarantees of less than 0.03 gr/dscf for high energy venturi scrubbers with operating pressure drops of greater than 50 in. H₂O.
- The May 1997 NODA proposed floor of 0.029 gr/dscf was based on floor control of venturi scrubbers.
- Various proposed rule and May 1997 NODA comments on the accepted performance of high energy venturi scrubbers on hazardous waste incinerators.

- Medical waste incinerator rules for medium sized existing sources and small sized new sources which are based on “medium” efficiency venturi scrubbers. See 62 FR 48348.

Note the de minimis metals alternative floor PM level is not offered for the other two HWC source categories (cement kiln and lightweight aggregate kilns). This is because cement kiln and LWAK waste fuels and other feedstreams (i.e., raw materials) would not meet the de minimis criteria. No cement kiln or LWAK in our database has metals levels in the hazardous waste feeds and raw materials that would meet the nondetect de minimis criteria, as shown in Chapter 12.3 and 12.4. That is to say, there are no CK or LWAKs which have non-detect levels of all non-mercury metals in all feedstreams.

4.2 CEMENT KILNS

Table 4-3 summarizes all PM test condition data from CKs, ranked by condition average, and shown as gas concentrations (in gr/dscf). The table is separated into 3 parts: (1) long kilns without in-line raw mill that are currently burning hazardous waste; (2) short kilns and those with in-line raw mills; and (3) those kilns no longer burning hazardous wastes. The table contains at least one test condition from every hazardous waste burning CK. PM test condition averages range widely from 0.001 to above the current BIF RCRA standard of 0.08 gr/dscf for hazardous waste cement kilns. Figure 4-2 displays PM levels from all hazardous waste burning CKs currently burning hazardous waste.

Table 4-4 shows PM test condition data from all CKs in terms of kg emitted PM per Mg of dry raw material feed, identical to the way the New Source Performance Standard (NSPS) is expressed for PM for all CKs. Figure 4-3 presents all PM emissions data. Test conditions highlighted with an “*” indicate that the CK is subject to the requirements of the NSPS. Figure 4-4 shows PM data only from hazardous waste burning cement kilns subject to the NSPS.

“Uncontrolled” PM grain loading into the APCS ranges from greater than 30 gr/dscf for dry-process kilns and 15 to 20 gr/dscf for wet-process kilns. The PM consists primarily of finely pulverized raw material fed to the kiln that is entrained with the flue gas exiting the kiln. FF and ESPs are used for PM emissions control on both wet- and dry-process cement kilns, sometimes preceded by cyclones for coarse bulk PM removal.

All but one of the hazardous waste burning wet kilns use ESPs. Wet kilns have historically preferred ESPs over FFs because: (1) when wet process kilns were first developed, fabrics suitable for relatively high temperature operation were not available; and (2) there was concern

about the high moisture content of wet kiln process flue gas and high PM alkali and chloride content resulting in blinding and plugging of filter bags. Also, ESPs have been historically preferred to FFs in the cement kiln industry because: (1) ESPs are reliable and easy to operate, control, and maintain; (2) ESPs catch dust in stages allowing for the recycle of dust caught in the first few fields back into the kiln and the wasting of alkali-concentrated dust in the latter fields; (3) the high moisture content of wet kiln flue gases improves operation of ESPs primarily by reducing the resistivity of the collected PM; and (4) the pressure drop of ESPs is low compared with FFs.

High temperature fabrics are now readily available, and FFs have extensive experience (in conjunction with spray dryers for acid gas control) in successfully operating at temperatures as low as 50°F above saturation conditions. Four wet-process cement kilns in the U.S. currently use FFs: Dragon Cement in Thomaston, ME, Giant Cement in Harleyville, SC (which burns hazardous wastes), Lafarge in Paulding, OH, and Holnam in Dundee, MI. It has been found that, with FFs on wet cement kiln processes, the higher moisture actually reduces dust handling problems and the increased dust agglomeration forces would be expected to reduce dust penetration of the fabric. This would result in a potential filtration efficiency improvement compared with operation on dry process kilns.

4.2.1 Existing Sources

The best performing cement kiln sources use FF and ESPs, and thus so does the average of the best performing 12% of sources. MACT control for existing sources is defined as the use of either a well designed and properly operated FF or ESP. For the proposed rule, an attempt was made to further define the control technology based on important characteristics known to influence technology performance, including specific collection area for ESPs and air-to-cloth ratio for FFs. However, these performance factors are not considered in the final rule floor analysis, as mentioned in Chapter 2, because:

- A strong correlation between a single criterion such as SCA or A/C ratio and PM performance does not exist.
- Many other characteristics are also important to technology performance. However, this information is not readily available to the Agency. For example:
 - For ESPs, control system design and operation, power input, plate spacing, rapping design, particle size, particle resistivity, etc.

- For FFs, cloth type, cleaning method and frequency, particle characteristics, etc.
- Information on SCA and A/C technology characteristics are limited (or unknown) for some kilns. Also, some characteristics may no longer apply due to equipment upgrades and retrofits.

The CK PM MACT floor is set as the New Source Performance Standard (NSPS) for Portland Cement kilns, developed in 1971, and is defined as 0.15 kg of PM per Mg of dry raw material feed and a limit on opacity of 20%.

The Portland Cement NSPS is appropriate as a MACT floor for hazardous waste burning CKs because:

- The NSPS is the most stringent federally enforceable PM standard currently applicable to cement plants, specifically to those that commenced construction or modification after August 17, 1971.
- Approximately 20% of the current HW-burning cement kilns are subject to the NSPS. Specifically, they are:
 - Giant Cement, Harleyville, SC (kiln 5)
 - Holnam, Holly Hill, SC (kiln 2)
 - Holnam, Artesia, MS (kiln 1)
 - Lafarge, Alpena, MI (kilns 22 and 23)
 - Lone Star, Cape Girardeau, MO (kiln 1)
 - Medusa, Demopolis, AL (kiln 1)
 - Texas Industries, Midlothian, TX (kiln 4)
- The NSPS level is representative of generally well operated and designed ESP and FFs, as discussed in more detail below.

The NSPS of 0.15 kg PM/Mg dry raw meal feed equates to a stack gas equivalent PM concentration of approximately 0.030 gr/dscf @ 7% O₂ for wet process kilns. The conversion of the NSPS to a concentration standard will vary by the kiln process type (e.g., wet, dry, preheater, precalciner) because the amount of flue gas generated per ton of raw material feed varies by the process type. The NSPS equates approximately to a stack gas concentration level of 0.030 gr/dscf for wet kilns, 0.037 gr/dscf for long dry kilns, 0.040 gr/dscf for preheater/precalciner kilns, and

0.051 gr/dscf for preheater kilns. The NSPS equivalent stack gas concentration for wet-type kilns is based on the following assumptions:

- 108,707 scf kiln exit gas per ton of clinker produced (p. 169 of K.E. Peray, “The Rotary Cement Kiln”, Second Edition, Chemical Publishing Co., Inc., New York, NY, 1986).
- Kiln exit gas moisture content of about 30% by volume and an oxygen level of about 4% by volume.
- 0.80 tons of clinker per ton of dry raw meal feed.

The PM MACT floor level based on the NSPS of 0.15 kg/Mg dry raw meal (with an approximate equivalent of 0.030 gr/dscf @ 7% O₂) is representative of well operated and designed ESPs and FFs, and is being achieved by currently operating HW cement kilns:

- PM levels from Portland Cement kilns subject to the NSPS (including those not burning, and burning hazardous wastes) range from very low levels, to levels right at, or just below, the NSPS. As shown in Figure 4-4, all but two conditions from hazardous waste burning CKs currently subject to the NSPS are meeting the NSPS level. For the two conditions that are not, the test reports clearly indicate that these PM levels are not representative of facility operations.
- The Portland Cement Association recently sponsored a study on the achievability of the NSPS based on routine variability of non-hazardous waste burning CKs (included as part of Portland Cement Association (PCA) Comments to the HWC Proposed MACT Rule). The study concluded that between the years of 1971 (the promulgation of the NSPS) and 1979, 47 of the 49 new kilns now under the NSPS met the 0.15 kg PM/Mg raw meal feed level. In the years between 1979 and 1985, all 27 new facilities met the NSPS, with most at less than half of the level. A current survey of APCD vendors by the PCA study indicated that all would guarantee emissions rates of 0.010 to 0.030 gr/dscf, which equates to approximately 0.05 to 0.11 kg per Mg of dry solids feed.
- ESPs are often “detuned” (not operated at maximum power input potential) during many of the CoC tests in order to set the lowest possible power operating limit. Thus, many of the CoC ESP PM results are not representative of the actual capabilities of the existing ESP.

- FFs that are being used by currently operating cement kilns have fabric materials that have been well demonstrated to readily achieve a PM level of 0.015 gr/dscf. Additionally, all cement kilns with fabric filters have multiple conditions meeting 0.15 kg/Mg raw material and 0.030 gr/dscf (almost all conditions with FFs have levels less than 0.030 gr/dscf).
- Many of the higher emitting facilities (higher than the approximate floor equivalent of 0.030 gr/dscf) are using older, smaller ESPs with SCAs less than 250 ft²/acfm (e.g., Source ID Nos. 300, 302, 401, 402).
- A number of hazardous waste burning cement kilns have recently made (or are planning) upgrades to their PM APCDs indicating that these sources are not likely employing well designed MACT controls. This information was provided by the Cement Kiln Recycling Coalition.
 - ESP rebuild at Lone Star in Greencastle, IN.
 - ESP refurbishment at Holnam in Holly Hill, SC.
 - ESP rebuild at Essroc in Logansport, IN.
 - ESP modification at Keystone in Bath, PA.
 - Field added to ESP at Ash Grove in Chanute, KS.
 - Removal of ESP and addition of new FF at Lafarge in Paulding, OH.
 - Addition of new FFs at TXI, Midlothian, TX (as well as wet scrubber and regenerative thermal oxidizer).
- The two short-dry process kilns and long dry kilns (both with and without in-line raw mills), which generally have higher PM inlet grain loadings, are achieving the floor of 0.15 kg/Mg raw material and floor equivalent level of 0.030 gr/dscf during at least one (and usually multiple) CoC test condition, at both the main and bypass stacks. This includes:
 - Source ID No. 321, a short kiln with in-line raw mill with separate main and bypass stacks, has multiple conditions with PM emissions of less than 0.015 gr/dscf at both the separate main and bypass stacks.
 - Source ID No. 303, a short kiln with in-line raw mill, has a couple of test conditions from a combined bypass and main stack with PM levels less than 0.030 gr/dscf.

Note that:

- On a total uncontrolled inlet loading concentration basis, the main stack may have a higher level of PM than the bypass due to entrainment of large quantities of ground raw materials in the main gases. Alternatively, the bypass may contain a higher percentage of fine particles (and thus be more difficult to control) compared with the main stack due to high levels of enriched and concentrated semi-volatile constituents that are contained in the bypass gas, compared with the main stack.
- PM emissions from in-line raw mill kilns are higher when the raw mill is operating.
- With the exception of four wet kilns, every CK has at least one (and often several) test condition below the NSPS level of 0.15 kg/Mg raw material and equivalent of 0.030 gr/dscf.

4.2.2 New Sources Floor

As for existing sources, MACT for new sources is defined as a well operated FF or ESP. This is because the PM control procedures used by the best controlled source are similar to those used by the best 6% of sources. Thus, the floor for new sources is the same as that for existing sources -- 0.15 kg of PM per Mg of dry raw material feed and a limit on opacity of 20%.

4.3 LIGHTWEIGHT AGGREGATE KILNS

Table 4-5 summarizes all PM test condition data from LWAKs, ranked by condition average. The data are from all hazardous waste burning LWAKs, many with multiple test conditions. Condition averages range from 0.001 to 0.025 gr/dscf. The table is separated into two sections: (1) LWAKs that are currently burning hazardous wastes; and (2) those that are not currently burning hazardous wastes.

Like CKs, LWAKs have a relatively high grain loading in the flue gas exiting the kiln, comprised mostly of entrained raw materials, and ranging from 10 to 15 gr/dscf. All LWAKs use FFs for PM control. One uses a FF with an additional VS. Most of the LWAK FFs were relatively new when the CoC testing was performed; both reverse air and pulse jet type FF units are used.

4.3.1 Existing Sources Floor

Based on the average of the best performing 12% of sources, MACT floor control is defined as the use of a well designed and properly operated and maintained FF. As discussed above for cement kilns, the MACT floor control technology was not characterized (e.g., FF A/C ratio) to identify poorly designed or operated units, as was done in the proposal, due to lack of sufficient quality data to fully characterize control equipment from all sources and/or a lack of relationship between the parameters and the system performance. Instead, as done in the incinerators and cement kiln floor analysis, the floor is determined by what MACT control can achieve in practice, based on an engineering information and principles evaluation. In particular, the floor is set at the highest test condition average determined to be using a well designed and operated FF. All LWAK PM data is shown in Figure 4-5. The LWAK MACT floor for PM is set at 0.025 gr/dscf (57 mg/dscm), which happens to be the highest test condition average. All test conditions from all LWAK were determined to be using MACT PM control because:

- The performance level of 0.025 gr/dscf is generally consistent with that expected from well designed and operated FFs and that achieved on other similar types of source categories with high grain loading such as cement kilns and certain municipal waste combustors.
- All of the LWAK FFs are similar in cloth type, design, and operation.
- There are no apparent SVM or LVM SRE outliers at these PM levels. All LWAKs are achieving greater than 99% SRE for both low and semi-volatile metals, with some sources attaining 99.99% removal.

The floor level is achievable considering expected variability:

- At least one CoC test series is available from each of the hazardous waste burning LWAKs. Multiple test conditions (from CoCs conducted at 5 year intervals) are available for most of the kilns. This number of test conditions likely covers the performance range and expected variation of well operated and designed FFs.
- The two highest test condition averages, Source ID Nos. 314C1 (at 0.025 gr/dscf) and 307C3 (at 0.023 gr/dscf), both have other test conditions that are less than 0.01 gr/dscf.

- Almost all individual test runs are less than 0.025 gr/dscf. All CoC LWAK condition averages are less than 0.025 gr/dscf; over 75% of all test conditions are less than 0.015 gr/dscf; 50% are less than 0.0075 gr/dscf.

4.3.2 New Sources

As for existing sources, MACT for new sources is defined as a well operated FF. This is because the PM control used by the best controlled similar source is similar to that used by the best 6% of sources. Thus, the floor for new sources is the same as that for existing sources -- 0.025 gr/dscf.

TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
Part 1. Incinerators Apparently Using MACT Control						
348C3	QC/AS/IWS	0.000	LI low ash	4/16/95	99.89	Liq Inj
337C1	WHB/DA/DI/FF	0.000	Starved air solid waste	2/28/92	99.80	Strv Air
348C2	QC/AS/IWS	0.000	LI low ash	4/16/95	99.99	Liq Inj
348C4	QC/AS/IWS	0.000	LI low ash	4/16/95	99.82	Liq Inj
325C8	SD/FF/WS/IWS	0.000	Nor	10/6/94	NA	Rot Kln
354C1	QC/AS/VS/DM/IWS	0.001	Rotary kiln sludge	4/1/92	99.99	Rot Kln
350C2	WHB/HE/FF	0.001	LI low ash	3/20/89	NA	Liq Inj
350C6	WHB/HE/FF	0.001	LI low ash	3/20/89	NA	Liq Inj
209C2	WHB/FF/VQ/PT/DM	0.001	LI high ash	6/20/91	100.00	Liq Inj
350C3	WHB/HE/FF	0.001	LI low ash	3/20/89	NA	Liq Inj
350C5	WHB/HE/FF	0.001	LI low ash	3/20/89	NA	Liq Inj
350C4	WHB/HE/FF	0.001	LI low ash	3/20/89	NA	Liq Inj
209C1	WHB/FF/VQ/PT/DM	0.001		6/20/91	99.99	Liq Inj
354C2	QC/AS/VS/DM/IWS	0.001		4/1/92	NA	Rot Kln
327C3	SD/FF/WS/WESP	0.001	Rotary kiln solid waste	8/1/92	99.65	Rot Kln
350C8	WHB/HE/FF	0.001		3/20/89	NA	Liq Inj
603B1	QT/S/IWS	0.001		5/20/90	NA	Rot Kln
350C9	WHB/HE/FF	0.001	LI low ash	3/20/89	NA	Liq Inj
612C1	SD/FF	0.001		1/21/97	NA	Fxd Hrth
349C3	QC/FF/QC/PT	0.001		6/1/93	99.99	Rot Kln
338C2	QC/FF/SS/C/HES/DM	0.001		8/1/90	NA	Rot Kln
327C1	SD/FF/WS/WESP	0.001		8/1/92	99.78	Rot Kln
349C2	QC/FF/QC/PT	0.001		6/1/93	NA	Rot Kln
603C1	QT/S/IWS	0.001		6/30/90	NA	Rot Kln
349C4	QC/FF/QC/PT	0.001	B	6/1/93	NA	Rot Kln
222C5	WHB/SD/CI/ESP/Q/PBS	0.001	Nor	2/1/94	NA	Rot Kln
341C2	DA/DI/FF/HEPA/CA	0.001	Mixed waste	10/1/93	95.16	Fxd Hrth
603C7	QT/S/IWS	0.001		5/20/90	NA	Rot Kln
338C1	QC/FF/SS/C/HES/DM	0.001	Nor	8/1/90	NA	Rot Kln
354C3	QC/AS/VS/DM/IWS	0.001		4/1/92	NA	Rot Kln
333C2	SD/FF	0.001		9/18/92	NA	Rot Kln
603C2	QT/S/IWS	0.001		6/30/90	NA	Rot Kln
209C7	WHB/FF/VQ/PT/DM	0.002		3/17/87	NA	Liq Inj
602C2	Q/S/C/DM/HEPA	0.002		7/15/97	99.99	Rot Kln
350C1	WHB/HE/FF	0.002		3/20/89	NA	Liq Inj
222C6	WHB/SD/CI/ESP/Q/PBS	0.002		4/1/94	NA	Rot Kln
603B3	QT/S/IWS	0.002		10/19/94	NA	Rot Kln
327C2	SD/FF/WS/WESP	0.002		8/1/92	99.40	Rot Kln
222B1	WHB/SD/CI/ESP/Q/PBS	0.002	Nor	1/1/95	NA	Rot Kln
325C6	SD/FF/WS/IWS	0.002		12/1/90	95.99	Rot Kln
348C1	QC/AS/IWS	0.002		2/10/94	99.69	Liq Inj
603C8	QT/S/IWS	0.002		5/20/90	99.92	Rot Kln
602C3	Q/S/C/DM/HEPA	0.002		7/15/97	99.99	Rot Kln

TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
222C3	WHB/SD/CI/ESP/Q/PBS	0.002		5/1/93	NA	Rot Kln
333C1	SD/FF	0.002		9/18/92	NA	Rot Kln
603C5	QT/S/IWS	0.002		9/21/92	NA	Rot Kln
222C8	WHB/SD/CI/ESP/Q/PBS	0.002	Nor	6/1/94	NA	Rot Kln
602C1	Q/S/C/DM/HEPA	0.002	Max metals feed	7/15/97	99.95	Rot Kln
603C6	QT/S/IWS	0.003		5/25/90	NA	Rot Kln
601C3	DS/FF/WS	0.003		5/1/96	98.11	Rot Kln
222C2	WHB/SD/CI/ESP/Q/PBS	0.003		5/1/93	NA	Rot Kln
209C4	WHB/FF/VQ/PT/DM	0.003		3/17/87	NA	Liq Inj
341C1	DA/DI/FF/HEPA/CA	0.003	Mixed waste	10/1/93	80.96	Fxd Hrth
222C1	WHB/SD/CI/ESP/Q/PBS	0.003		5/1/93	99.99	Rot Kln
471C1	QT/FF	0.003		3/1/95	NA	Fxd Hrth
222B2	WHB/SD/CI/ESP/Q/PBS	0.003	Nor	3/1/95	NA	Rot Kln
1000C2	HE/FF/HEPA	0.003		1/1/97	NA	Contr Air
600C3	WHB/QC/PT/IWS	0.003		12/14/95	NA	Rot Kln
359C4	WHB/FF/S	0.003		6/1/90	NA	Rot Kln
222B3	WHB/SD/CI/ESP/Q/PBS	0.003	Nor	9/12/95	99.99	Rot Kln
222C7	WHB/SD/CI/ESP/Q/PBS	0.003	Nor	5/1/94	NA	Rot Kln
325C4	SD/FF/WS/IWS	0.004		12/1/90	98.10	Rot Kln
325C5	SD/FF/WS/IWS	0.004		12/1/90	94.40	Rot Kln
603C9	QT/S/IWS	0.004		5/20/90	NA	Rot Kln
222C9	WHB/SD/CI/ESP/Q/PBS	0.004	Nor	9/1/94	NA	Rot Kln
351C2	C/HE/FF	0.004		1/31/92	NA	Rot Kln
209C8	WHB/FF/VQ/PT/DM	0.005		3/17/87	NA	Liq Inj
601C1	DS/FF/WS	0.005		5/1/96	99.13	Rot Kln
325C7	SD/FF/WS/IWS	0.005		12/1/90	99.46	Rot Kln
600C2	WHB/QC/PT/IWS	0.005		11/23/88	NA	Rot Kln
349C1	QC/FF/QC/PT	0.005		6/1/93	NA	Rot Kln
340C2	WHB/ESP/WS	0.005		9/1/92	99.65	Fld Bed
351C1	C/HE/FF	0.005		1/31/92	NA	Rot Kln
603C3	QT/S/IWS	0.006		9/21/92	NA	Rot Kln
209C5	WHB/FF/VQ/PT/DM	0.007		3/17/87	NA	Liq Inj
210C2	SD/FF/PT	0.007		1/1/94	NA	Rot Kln
603C4	QT/S/IWS	0.007		9/21/92	NA	Rot Kln
357C50	VS/PT/IWS	0.007	Mixed waste	9/15/95	NA	Rot Kln
340C1	WHB/ESP/WS	0.008		9/1/92	99.90	Fld Bed
1000C1	HE/FF/HEPA	0.008		1/1/97	NA	Contr Air
209C3	WHB/FF/VQ/PT/DM	0.008		3/17/87	NA	Liq Inj
331C1	PT/IWS	0.008		3/1/93	NA	Rot Kln
353C1	QC/VS/DM/WESP	0.008		7/1/89	NA	Rot Kln
210C1	SD/FF/PT	0.008		1/1/93	NA	Rot Kln
211C1	SD/FF/PT	0.009		3/1/93	NA	Rot Kln
359C5	WHB/FF/S	0.009		6/1/90	NA	Rot Kln
1001C3	C/HE/FF	0.009		12/6/93	NA	Rot Kln

TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
1001C2	C/HE/FF	0.010		12/6/93	NA	Rot Kln
600C1	WHB/QC/PT/IWS	0.010		11/23/88	NA	Rot Kln
727C1	C/HE/FF	0.010		11/14/88	NA	Rot Kln
601C2	DS/FF/WS	0.011		5/1/96	98.80	Rot Kln
808C2	QT/PBS/WESP	0.011		2/10/88	NA	Rot Kln
209C6	WHB/FF/VQ/PT/DM	0.011		3/17/87	NA	Liq Inj
353C2	QC/VS/DM/WESP	0.011		7/1/89	NA	Rot Kln
351C3	C/HE/FF	0.012		1/31/92	NA	Rot Kln
350C7	WHB/HE/FF	0.013	FF bypassed	3/20/89	NA	Liq Inj
1001C5	C/HE/FF	0.013		12/6/93	NA	Rot Kln
351C4	C/HE/FF	0.014		9/7/93	NA	Rot Kln
359C1	WHB/FF/S	0.014		4/21/89	NA	Rot Kln
708C3	VS/PT/WESP	0.014		11/18/92	NA	Liq Inj
331C3	Q/PT/IWS/DM	0.015		5/1/92	99.20	Rot Kln
503C3	C/HE/FF	0.016		5/30/91	84.25	Rot Kln
214C1	Q/IWS	0.017		4/28/87	NA	Rot Kln
454C1	VQ/PT/CT/WESP	0.018		8/1/86	NA	Liq Inj
503C4	C/HE/FF	0.019		5/30/91	99.85	Rot Kln
214C3	Q/IWS	0.019		5/3/88	99.72	Rot Kln
359C2	WHB/FF/S	0.019		4/21/89	NA	Rot Kln
1001C4	C/HE/FF	0.020		12/6/93	NA	Rot Kln
503C5	C/HE/FF	0.021		5/30/91	NA	Rot Kln
212C1	SD/FF/PT	0.022		3/1/93	NA	Rot Kln
331C2	Q/PT/IWS/DM	0.024		5/1/92	98.23	Rot Kln
357C1	QC/VS/PT/IWS	0.025	Mixed waste	8/31/89	NA	Rot Kln
705C1	QT/VS/PT/WESP	0.025		3/22/90	-45657	Rot Kln
708C1	VS/PT/WESP	0.025		11/18/92	NA	Liq Inj
354C4	QC/AS/VS/DM/IWS	0.026		4/1/92	NA	Rot Kln
359C3	WHB/FF/S	0.026		4/21/89	NA	Rot Kln
808C1	QT/PBS/WESP	0.027		2/10/88	NA	Rot Kln
503C1	C/HE/FF	0.028		3/1/93	99.77	Rot Kln
214C2	Q/IWS	0.028		5/3/88	99.54	Rot Kln
503C6	C/HE/FF	0.029		5/30/91	NA	Rot Kln
503C2	C/HE/FF	0.029		3/1/93	98.67	Rot Kln
603B2	QT/S/IWS	0.035		5/20/90	NA	Rot Kln
331C5	Q/PT/IWS/DM	0.039		4/1/89	NA	Rot Kln
353C3	QC/VS/DM/WESP	0.047	353C1/C2	7/1/89	NA	Rot Kln
334C3	WHB/Q/WS/WESP/PT/WS	0.048	Nor	3/11/88	NA	Rot Kln
331C9	Q/PT/IWS/DM	0.048		4/1/89	NA	Rot Kln
705C2	QT/VS/PT/WESP	0.052	705C1	3/22/90	-99	Rot Kln
331C7	Q/PT/IWS/DM	0.053		4/1/89	NA	Rot Kln
708C2	VS/PT/WESP	0.056		11/18/92	NA	Liq Inj
334C2	WS/WESP/PT	0.058		9/6/90	-234	Rot Kln
331C6	Q/PT/IWS/DM	0.060		4/1/89	NA	Rot Kln

TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
331C8	Q/PT/IWS/DM	0.060		4/1/89	NA	Rot Kln
331C4	Q/PT/IWS/DM	0.060		4/1/89	NA	Rot Kln
1001C1	C/HE/FF	0.062		12/6/93	NA	Rot Kln
334C1	WS/WESP/PT	0.062		9/6/90	93.74	Rot Kln
825C1	CCS/QC/WESP	0.065		6/24/84	NA	Rot Kln
359C6	WHB/FF/S	0.077		6/1/90	NA	Rot Kln
727C2	C/HE/FF	0.157	EFS	11/14/88	NA	Rot Kln

Part 2. Incinerators Not Using MACT Control of ESP, FF, or IWS

347C4	C/QT/VS/PBS/DM	0.001	B	4/1/92	NA	Rot Kln
344C3	QC/VS/PT/DM	0.001		2/1/93	NA	Liq Inj
346C1	C/QC/VS/PT/DM	0.001		6/23/92	NA	Rot Kln
726C2	QC/CS/DM/VS	0.001		8/28/88	NA	Liq Inj
344C1	QC/VS/PT/DM	0.001		6/23/92	NA	Liq Inj
344C2	QC/VS/PT/DM	0.002		6/17/91	NA	Liq Inj
470C1	QT/VS/PBS/DM	0.002		12/16/92	NA	Fxd Hrth
493C1	C/QT/VS/PBS/DM	0.002		7/7/97	NA	
347C2	C/QT/VS/PBS/DM	0.003	B	10/1/93	NA	Rot Kln
606C2	WHB/S	0.003		8/23/95	NA	
455C4	NONE	0.003		9/1/88	NA	Liq Inj
606C1	WHB/S	0.003		8/23/95	NA	
483C1	NONE	0.003	LI	1/13/89	NA	Liq Inj
714C4	PBS	0.003		1/27/89	NA	Liq Inj
904C2	WHB	0.003		7/1/91	NA	Strv Air
726C1	QC/CS/DM/VS	0.004		8/28/88	NA	Liq Inj
347C8	C/QT/VS/PBS/DM	0.004		4/9/97	NA	Rot Kln
342C1	WHB/QC/S/VS/DM	0.004		3/16/92	NA	Rot Kln
704C3	WHB	0.005	LI	2/16/94	NA	Liq Inj
614C2	S	0.005	Nor, CA	11/1/94	NA	
456C1	NONE	0.005		7/26/84	NA	Liq Inj
714C3	PBS	0.006		1/27/89	NA	Liq Inj
480C2	QC/HS	0.006		5/31/94	NA	Rot Kln
455C2	NONE	0.006		9/1/88	NA	Liq Inj
613C3	WHB/Q/S/PBS	0.006		2/1/85	NA	Rot Kln
461C1	NONE	0.006		11/1/88	NA	Liq Inj
614C1	S	0.006	Nor, CA	11/1/94	NA	
824C1	QT/VS/PT/DM	0.006		10/1/89	88.77	Liq Inj
324C6	WHB	0.006		2/1/90	NA	Batch
610C1	S	0.006	Nor	12/1/91	NA	
455C3	NONE	0.007		9/1/88	NA	Liq Inj
324C7	WHB	0.007		2/1/90	NA	Batch
506C1	WHB	0.007		11/1/86	NA	
483C3	NONE	0.007	LI	1/13/89	NA	Liq Inj

TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
613C2	WHB/Q/S/PBS	0.007		2/1/85	NA	Rot Kln
614C3	S	0.007	Nor, CA	11/1/94	NA	
613C1	WHB/Q/S/PBS	0.008		2/1/85	NA	Rot Kln
324C5	WHB	0.008		2/1/90	NA	Batch
605C1	WS	0.008	Nor	12/8/93	NA	
488C3	SS/PT/VS/DM	0.008		9/1/89	42.59	Rot Kln
457C1	NONE	0.008		3/1/81	NA	Liq Inj
494C1	C/QT/VS/PBS/DM	0.009		8/15/97	NA	
490C2	SS/PBS	0.009		6/1/94	NA	Rot Kln
505C4	WHB	0.009		12/1/88	NA	
714C2	PBS	0.009		1/27/89	NA	Liq Inj
505C3	WHB	0.010		12/1/88	NA	
613C4	WHB/Q/S/PBS	0.010		2/1/85	NA	Rot Kln
229C1	WHB/ACS/HCS/CS	0.010		4/16/91	95.87	Liq Inj
488C2	SS/PT/VS/DM	0.010		9/1/89	-29	Rot Kln
347C3	C/QT/VS/PBS/DM	0.011		4/1/92	NA	Rot Kln
490C1	SS/PBS	0.011	Metals spiking	6/1/94	97.66	Rot Kln
347C1	C/QT/VS/PBS/DM	0.012		10/1/93	NA	Rot Kln
229C2	WHB/ACS/HCS/CS	0.012		4/16/91	96.60	Liq Inj
221C5	SS/PT/VS	0.013		8/1/88	97.79	Rot Kln
609C1	SS/PT/VS/DM	0.013		4/1/95	NA	Rot Kln
904C1	WHB	0.013		7/1/91	NA	Strv Air
221C3	SS/PT/VS	0.013		8/1/88	98.90	Rot Kln
488C1	SS/PT/VS/DM	0.013		9/1/89	26.89	Rot Kln
489C1	SS/PT/VS/DM	0.013		10/1/89	98.40	Rot Kln
324C3	WHB	0.014		2/1/89	-3595	Batch
221C1	SS/PT/VS	0.014		8/1/88	26.15	Rot Kln
221C2	SS/PT/VS	0.015		8/1/88	99.72	Rot Kln
480C1	QC/HS	0.015		5/31/94	NA	Rot Kln
221C4	SS/PT/VS	0.015		8/1/88	90.34	Rot Kln
707C3	OS/QC/WS	0.015		1/5/89	NA	Liq Inj
704C1	WHB	0.015		12/22/88	NA	Liq Inj
613C5	WHB/Q/S/PBS	0.016		2/1/85	NA	Rot Kln
904C3	WHB	0.016		7/1/91	NA	Strv Air
461C2	NONE	0.017		11/1/88	NA	Liq Inj
455C1	NONE	0.017		4/1/85	NA	Liq Inj
229C3	WHB/ACS/HCS/CS	0.017		2/12/91	-199	Liq Inj
229C4	WHB/ACS/HCS/CS	0.018		2/12/91	NA	Liq Inj
324C1	WHB	0.018		2/1/89	85.97	Batch
458C2	VS/PT/QT	0.018		10/1/90	95.37	Liq Inj
486C1	VQ/C/PT/ES	0.019		4/10/92	NA	Rot Kln
904C4	WHB	0.019		4/1/95	NA	Strv Air
458C1	VS/PT/QT	0.019		6/19/85	NA	Liq Inj
504C1	VS/C	0.021		10/11/91	99.70	Fld Bed

TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
216C7	HES/WS	0.021		2/1/90	NA	Rot Kln
725C1	WS/QT	0.022		6/19/90	NA	Liq Inj
711C1	C/VS/AS	0.022		2/12/88	NA	LI/RK
704C2	WHB	0.022		12/22/88	NA	Liq Inj
702A3	QT/S/C	0.022		2/1/89	NA	Liq Inj
712C2	WHB	0.023		10/1/92	32.65	Liq Inj
904C5	WHB	0.023		4/1/95	NA	Strv Air
324C2	WHB	0.023		2/1/89	7.02	Batch
915C3	QC/VS/C	0.024		9/1/92	NA	Rot Kln
487C1	WS	0.024		4/12/92	NA	Rot Kln
711C4	C/WHB/VS/AS	0.024		4/1/97	NA	LI/RK
229C6	WHB/ACS/HCS/CS	0.026		2/12/91	-573	Liq Inj
358C2	QC/VS/C/CT/S/DM	0.026		2/14/89	NA	Liq Inj
701C2	VS/PT	0.026		2/21/89	NA	Rot Kln
358C4	QC/VS/C/CT/S/DM	0.027		2/14/89	NA	Liq Inj
216C6	HES/WS	0.027		8/1/88	NA	Rot Kln
505C5	WHB	0.027		6/1/89	NA	
216C1	HES/WS	0.028		10/1/86	NA	Rot Kln
706C3	QT/HS/C/DM	0.028		5/3/88	NA	
707C7	OS/QC/WS	0.029		1/5/89	NA	Liq Inj
480C3	QC/HS	0.029		5/31/94	NA	Rot Kln
324C4	WHB	0.029		2/1/89	93.68	Batch
700C2	SD/RJS/VS/WS	0.030		11/1/92	NA	Fxd Hrth
806C2	C/VS	0.031		6/1/89	NA	Fld Bed
487C2	WS	0.031		4/12/92	NA	Rot Kln
229C5	WHB/ACS/HCS/CS	0.031		2/12/91	-225	Liq Inj
711C2	C/VS/AS	0.031		2/12/88	NA	LI/RK
701C1	VS/PT	0.032		2/21/89	NA	Rot Kln
707A2	OS/QC/WS	0.033		1/5/89	NA	Liq Inj
358C1	QC/VS/C/CT/S/DM	0.033		2/14/89	NA	Liq Inj
216C5	HES/WS	0.033		8/1/88	NA	Rot Kln
465C2	QT/S	0.033		10/12/88	NA	Liq Inj
707C2	OS/QC/WS	0.034		1/5/89	NA	Liq Inj
714C5	PBS	0.035		1/27/89	NA	Liq Inj
477C1	QT/PT/VS/D	0.035		8/9/89	NA	Liq Inj
906C5	QT/PT	0.036		5/17/89	NA	Liq Inj
477C2	QT/PT/VS/D	0.037		8/9/89	NA	Liq Inj
707C4	OS/QC/WS	0.037		1/5/89	NA	Liq Inj
784C1	?	0.037		8/29/89	NA	
712C1	WHB	0.038		2/1/93	-164	Liq Inj
706C1	QT/HS/C/DM	0.038		5/3/88	NA	
714C1	PBS	0.038		1/27/89	NA	Liq Inj
707C1	OS/QC/WS	0.038		1/5/89	NA	Liq Inj
468C1	Q/VS	0.038		11/12/84	NA	Liq Inj

TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
453C1	NONE	0.039		8/1/88	NA	Liq Inj
460C1	?	0.040		9/18/84	NA	Liq Inj
460C3	?	0.042		9/18/84	NA	Liq Inj
483C2	NONE	0.042	LI	1/13/89	NA	Liq Inj
702A2	QT/S/C	0.042		2/1/89	NA	Liq Inj
460C2	?	0.043		9/18/84	NA	Liq Inj
358C3	QC/VS/C/CT/S/DM	0.043		2/14/89	NA	Liq Inj
711C3	C/VS/AS	0.043		2/12/88	NA	LI/RK
728C1	QT/PT/VS	0.044		11/18/87	NA	Inc
784C2	?	0.044		8/30/89	NA	
707C8	OS/QC/WS	0.045		1/5/89	NA	Liq Inj
505C1	WHB	0.045		12/1/88	NA	
707A1	OS/QC/WS	0.046		1/5/89	NA	Liq Inj
702A1	QT/S/C	0.047		2/1/89	NA	Liq Inj
487C3	WS	0.049		4/12/92	NA	Rot Kln
805C1	QT/QS/VS/ES/PBS	0.054		8/9/89	NA	LI/FH
216C4	HES/WS	0.055		8/3/83	NA	Rot Kln
806C1	C/VS	0.056		6/1/89	NA	Fld Bed
700C1	SD/RJS/VS/WS	0.057		11/1/92	86.22	Fxd Hrth
915C2	QC/VS/C	0.058		9/1/92	NA	Rot Kln
607C1	NONE	0.061		3/25/83	NA	
706C2	QT/HS/C/DM	0.062		5/3/88	NA	
484C2	WHB/QT/VS	0.064	LI, dissolved salts	7/1/87	NA	Liq Inj
906C1	QT/PT	0.066	Nor	5/17/89	NA	Liq Inj
701C3	VS/PT	0.069		2/21/89	NA	Rot Kln
915C4	QC/VS/C	0.071		9/1/92	NA	Rot Kln
702C7	QT/S/C	0.072		2/1/89	NA	Liq Inj
906C3	QT/PT	0.072	Nor	5/17/89	NA	Liq Inj
915C1	QC/VS/C	0.076		9/1/92	NA	Rot Kln
459C1	S	0.077		10/18/85	NA	Liq Inj
465C1	QT/S	0.078	EFS	10/12/88	NA	Liq Inj
464C1	?	0.080	Nor, EFS	10/1/87	NA	
906C4	QT/PT	0.087	EFS	5/17/89	NA	Liq Inj
906C2	QT/PT	0.089	EFS	5/17/89	NA	Liq Inj
702C6	QT/S/C	0.090	EFS	2/1/89	NA	Liq Inj
702C8	QT/S/C	0.109	EFS	2/1/89	NA	Liq Inj
463C1	QT/VS/S	0.112	EFS	11/13/84	NA	Liq Inj
505C2	WHB	0.140		12/1/88	NA	
702C9	QT/S/C	0.188	EFS	2/1/89	NA	Liq Inj
707C9	OS/QC/WS	1.901	EFS	1/5/89	NA	Liq Inj

Part 3. Incinerators No Longer Burning Hazardous Waste

500C4	QC/VS/KOV/DM	0.000	NLBHW, LI low ash	6/1/93	NA	Liq Inj
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TABLE 4-1. INCINERATOR PM

EPA Cond ID	APCS	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date	SVM SRE %	Comb Type
500C3	QC/VS/KOV/DM	0.001	NLBHW	7/18/88	NA	Liq Inj
500C1	QC/VS/KOV/DM	0.002	NLBHW	7/18/88	97.64	Liq Inj
703C2	WHB	0.002	NLBHW	1/1/89	NA	Liq Inj
339C1	AT/PT/RJS/WESP	0.003	NLBHW	6/1/89	NA	Inc
703C1	WHB	0.004	NLBHW	1/1/89	NA	Liq Inj
500C2	QC/VS/KOV/DM	0.004	NLBHW	7/18/88	NA	Liq Inj
914C1	?	0.004	NLBHW	12/5/91	NA	
400C1	SD/FF	0.006	NLBHW	7/1/91	99.97	Rot Kln
467C4	C/S	0.012	NLBHW	10/6/87	NA	
710C1	QT/OS/C/S	0.017	NLBHW	9/29/89	NA	LI/RK
710C2	QT/OS/C/S	0.021	NLBHW	9/29/89	NA	LI/RK
902C1	QT/VS/PT	0.021	NLBHW	12/1/93	90.23	Sub Qnch
807C2	C/WHB/VQ/PT/HS/DM	0.022	NLBHW	7/18/91	99.86	Rot Kln
710C4	QT/OS/C/S	0.022	NLBHW	9/9/93	NA	LI/RK
330C1	QT/PBS/DM	0.023	NLBHW	4/1/91	-26	Liq Inj
903C3	VS/PT/CA/HEPA	0.024	NLBHW	1/1/92	NA	Rot Kln
710C5	QT/OS/C/S	0.025	NLBHW	9/9/93	98.97	LI/RK
903C1	VS/PT/CA/HEPA	0.025	NLBHW	1/1/92	NA	Rot Kln
807C3	C/WHB/VQ/PT/HS/DM	0.028	NLBHW	7/18/91	99.88	Rot Kln
462C2	S	0.031	NLBHW	2/1/85	NA	Liq Inj
329C1	PT/IWS	0.031	NLBHW	3/27/92	95.24	Rot Kln
903C2	VS/PT/CA/HEPA	0.032	NLBHW	1/1/92	NA	Rot Kln
356C1	QC/AS/FN/PBS/DM	0.032	NLBHW	7/14/89	NA	Liq Inj
807C1	C/WHB/VQ/PT/HS/DM	0.034	NLBHW	7/18/91	99.85	Rot Kln
502C1	WHB/QC/PBC/VS/ES	0.036	NLBHW	7/1/90	NA	Rot Hrth
710C3	QT/OS/C/S	0.042	NLBHW	9/29/89	NA	LI/RK
332C2	HES	0.045	NLBHW	5/21/87	NA	Fxd Hrth
709C1	WHB	0.051	NLBHW	7/27/89	NA	Liq Inj
462C1	S	0.052	NLBHW	2/1/85	NA	Liq Inj
330C2	QT/PBS/DM	0.059	NLBHW	4/1/91	29.85	Liq Inj
467C3	C/S	0.061	NLBHW	10/6/87	NA	
332C3	HES	0.063	NLBHW	4/6/87	NA	Fxd Hrth
713C1	VS/PT	0.065	NLBHW	5/1/89	NA	Rot Kln
332C1	HES	0.114	NLBHW, EFS	3/1/87	NA	Fxd Hrth
467C1	C/S	0.156	NLBHW, EFS	10/6/87	NA	
356C3	QC/AS/FN/PBS/DM	0.184	NLBHW, EFS	6/25/87	NA	Liq Inj

TABLE 4-2. PILOT-SCALE PERFORMANCE EVALUATIONS OF VARIOUS FABRIC FILTER TYPES

Fabric Type	PM Emissions (gr/dscf)	Inlet PM Grain Loading (gr/dscf)	PM Size (μm)	FF A/C	Reference
9.5-ounce twill felt	0.041	15	0.5	2.7	1
12-ounce triloft	0.002	15	0.5	2.7	1
13.5-ounce twill felt	0.006	15	0.5	2.7	1
PTFE membrane	0.002	15	0.5	2.7	1
12-ounce needle felt	0.016	10	n/a	n/a	3
16-ounce needle felt	0.012	10	n/a	n/a	3
16-ounce dense needle felt	0.008	10	n/a	n/a	3
22-ounce needle felt	0.004	10	n/a	n/a	3
16-ounce laminate/membrane felt	0.001	10	n/a	n/a	3
Goretex (PTFE membrane)	0.0001	3	coal fly ash	4.5	2
16-oz fiberglass felt	0.0002	3	coal fly ash	4.5	2
27-oz fiberglass felt	0.0002	3	coal fly ash	4.5	2
Polyimide felt	0.0003	3	coal fly ash	4.5	2
Nomex	0.0009	3	coal fly ash	4.5	2
Polyphenylene sulfide felt	0.0012	3	coal fly ash	4.5	2
22-oz woven fiberglass	0.0031	3	coal fly ash	4.5	2
16-oz woven fiberglass	0.0036	3	coal fly ash	4.5	2

1: Information supplied by a FF vendor, and documented in "Technical Feasibility of Meeting Low Particulate Matter Standards," prepared by Energy and Environmental Research Corp. under EPA Contract No. 68-D2-0164, June 27, 1994.

2: R.J. Davis, T.R. Kiska, and S.W. Felix, "A Comparative Evaluation of High-Temperature Pulse-Jet Baghouse Filter Fabrics," *Proceedings of the 1990 National Waste Processing Conference*, sponsored by the American Society of Mechanical Engineers, Long Beach, CA, June 3-6, 1990.

3: W.J. Klimezak, "The Interrelationships of Factors that Affect Dust Collector Efficiency," *Powder and Bulk Engineering*, p. 40, October 1998.

TABLE 4-3. CEMENT KILN PM

EPA Cond ID	APCS	EPA A/C SCA	CKRC A/C SCA	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date
Part 1. Long and non in-line raw mill kilns						
200C5	FF	4	2	0.002		8/1/95
320C3	FF	2.3	1.7	0.002	NSPS	8/1/95
205C5	ESP	570		0.002		9/15/95
206C9	ESP	500		0.003	NSPS, B	8/9/95
205C6	ESP	570		0.003		9/15/95
320C1	FF	2.3	1.7	0.003	NSPS	8/1/92
200C4	FF	4	2	0.004	Metals spiking	8/1/95
404C4	ESP	580	580	0.004		1/17/95
404C2	ESP	580	580	0.004		11/1/92
323C9	ESP	240	360	0.005		6/1/96
304C6	ESP	350	603	0.006		7/18/94
319B5	ESP	1100	280	0.006		8/23/93
207C3	MC/ESP		288	0.007		1/1/97
404C1	ESP	580	580	0.007	High LVM ND	11/1/92
204B2	ESP	350	590	0.008	Nor	9/13/96
206C7	ESP	500		0.008	NSPS, Nor	8/9/95
304C5	ESP	350	603	0.008	Nor	9/29/94
305B3	ESP	340		0.008	Nor	10/7/96
319D1	ESP	1100	280	0.008	Nor	2/16/95
319D2	ESP	1100	280	0.009		2/16/95
205C8	ESP	570		0.009	Nor	8/9/95
206C6	ESP	500		0.009	NSPS	9/15/95
335C6	ESP	420		0.009		7/8/93
203C5	ESP	220	480	0.009	Max metals feed	8/16/96
318C1	ESP	435	430	0.010		5/24/93
473C2	ESP		430	0.010		5/8/95
305C5	ESP	340		0.010		6/24/94
319B2	ESP	1100	280	0.010	Nor	8/23/93
206C8	ESP	500		0.010	NSPS	8/9/95
201C1	FF	4	2	0.011	NSPS	8/21/92
319B6	ESP	1100	280	0.011	B	8/23/93
404C5	ESP	580	580	0.012		1/17/95
335B1	ESP	420		0.012		8/11/95
204B3	ESP	350	590	0.012	Max metals feed	9/13/96
323B1	ESP	240	360	0.012	B	6/1/96
228C2	ESP	454		0.013		5/1/92
403C4	ESP	230		0.013		11/1/94
322C8	ESP	370	360	0.013		11/1/95
300C3	ESP	360	200	0.013	Nor	7/28/93
200C1	FF	4	2	0.013		8/21/92
320C5	FF	2.3	1.7	0.014	NSPS, Nor	1/17/95
203C1	ESP	220	480	0.014	NSPS	8/19/93

TABLE 4-3. CEMENT KILN PM

EPA Cond ID	APCS	EPA A/C SCA	CKRC A/C SCA	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date
681C1	FF		2	0.014		11/10/93
208C1	ESP		430	0.014		1/1/93
323C8	ESP	240	360	0.014		9/1/94
681C2	FF		2	0.015		6/5/91
203C6	ESP	220	480	0.015		8/16/96
208C2	ESP		430	0.016		1/1/93
203C4	ESP	220	480	0.016	NSPS	8/19/93
208C3	ESP		430	0.017		1/1/97
680C1	FF		2	0.018		11/11/93
203C2	ESP	220	480	0.018	NSPS	5/24/94
207C2	MC/ESP		288	0.018		1/1/93
319B3	ESP	1100	280	0.018		8/23/93
322C1	ESP	370	360	0.019		8/1/92
323B2	ESP	240	360	0.020		6/1/96
323C1	ESP	240	360	0.022		8/1/92
206C1	ESP	500		0.023	NSPS	8/1/92
305B2	ESP	340		0.023		8/11/88
335C1	ESP	420		0.023		6/1/92
300C6	ESP	360	200	0.023	B	5/1/87
200C2	FF	4	2	0.023		5/1/89
204C9	ESP	350	590	0.024		9/13/96
201C2	FF	4	2	0.024	NSPS	1/30/91
322C3	ESP	370	360	0.024		9/1/94
204B4	ESP	350	590	0.025	Nor	11/6/95
228C6	ESP	454		0.026		10/1/88
323B3	ESP	240	360	0.026		11/1/95
335C8	ESP	420		0.028		1/1/86
207C1	MC/ESP		288	0.028		1/1/93
403C1	ESP	230		0.029	High SVM ND	10/1/92
206C5	ESP	500		0.029	NSPS	9/15/95
403C3	ESP	230		0.029		11/1/94
335B2	ESP	420		0.030	Nor	10/7/96
403C2	ESP	230		0.031		10/1/92
402C1	ESP	230		0.033	High SVM ND	3/27/92
302C1	ESP	250	325	0.034		8/1/92
204C1	ESP	350	590	0.034		7/1/92
319C1	ESP	1100	280	0.037		5/5/92
319B8	ESP	1100	280	0.041	Nor	5/22/92
401C4	ESP	250		0.041		3/1/94
404C3	ESP	580	580	0.041		1/17/95
300C7	ESP	360	200	0.044		5/1/87
401C1	ESP	250		0.048	High LVM ND, Outlier LVM SRE	4/9/92
401C3	ESP	250		0.049		3/1/94
205C1	ESP	570		0.050		8/1/92

TABLE 4-3. CEMENT KILN PM

EPA Cond ID	APCS	EPA A/C SCA	CKRC A/C SCA	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date
302C4	ESP	250	325	0.050		8/1/95
304C1	ESP	350	603	0.056		8/1/92
201C3	FF	4	2	0.056	NSPS, Nor	6/22/89
302C3	ESP	250	325	0.060		8/1/95
302C2	ESP	250	325	0.061		9/1/94
491C1	ESP			0.063	Max metals feed	8/15/95
305C1	ESP	340		0.063	High SVM ND	3/1/93
228C7	ESP	454		0.069		10/1/88
335C9	ESP	420		0.071	B	3/27/84
300C1	ESP	360	200	0.071		8/20/92
401C5	ESP	250		0.077	EFS	3/1/94
305C3	ESP	340		0.077	EFS	8/20/92
305C2	ESP	340		0.080	EFS	3/1/93
402C5	ESP	230		0.085	EFS	4/4/94
335C7	ESP	420		0.094	B, EFS	1/1/86
472C1	ESP			0.100	EFS	5/1/91
305C6	ESP	340		0.113	Nor, EFS	3/6/90
472C2	ESP			0.900	EFS	5/1/91
402C4	ESP	230		12.975	BPM prior to APCD	4/4/94
402C3	ESP	230		31.567	BPM prior to APCD	4/4/94

Part 2. Short and in-line raw mill kilns

321C4	ESP	650	700	0.001	NSPS, Short, ILRM (on), BPM, Nor	10/13/93
321C3	ESP	650	700	0.004	NSPS, Short, ILRM (off), BPM, B	10/13/93
321C3	ESP	420	700	0.005	NSPS, Short, ILRM, B	10/13/93
321C4	ESP	420	700	0.007	NSPS, Short, ILRM (on), Nor	10/13/93
321C5	ESP	650	700	0.011	NSPS, Short, ILRM (on), BPM	8/1/95
303C6	QC/FF	2\1	2\1	0.017	NSPS, Short, ILRM (on), CMBM	9/1/92
321C5	ESP	420	700	0.018	NSPS, Short, ILRM (on)	8/1/95
202C1	FF	1.9	2.6	0.022	ILRM	10/1/92
303C1	QC/FF	2\1	2\1	0.023	NSPS, Short, ILRM (off), B, CMBM, Outlier	1/1/93
303C2	QC/FF	2\1	2\1	0.024	NSPS, Short, ILRM (on), CMBM	1/1/93
303C7	QC/FF	2\1	2\1	0.025	NSPS, Short, ILRM (off), CMBM	12/1/95
202C5	FF	1.9	2.6	0.030	ILRM (off)	12/1/96
202C2	FF	1.9	2.6	0.031	ILRM (off)	10/1/92
321C1	ESP	650	700	0.040	NSPS, Short, ILRM (on), BPM	8/1/92
202C6	FF	1.9	2.6	0.046	ILRM (on)	12/1/96
321C1	ESP	420	700	0.060	NSPS, Short, ILRM (on)	8/1/92

Part 3. Kilns no longer burning hazardous waste

315C2	FF	1.8	1.8	0.001	NSPS, Short, NLBHW, ILRM (on)	7/15/92
315C1	FF	1.8	1.8	0.001	NSPS, Short, NLBHW, ILRM (on)	7/15/92

TABLE 4-3. CEMENT KILN PM

EPA Cond ID	APCS	EPA A/C SCA	CKRC A/C SCA	PM Cond Avg (gr/dscf)	Summary Comments	Cond Date
317C3	FF	1.3	1.7/8	0.002	NSPS, Short, NLBHW, ILRM (on), B	1/22/93
317C1	FF	1.3	1.7/8	0.002	NSPS, Short, NLBHW, ILRM (on)	1/22/93
315C5	FF	1.8	1.8	0.003	NSPS, Short, NLBHW, ILRM (on)	4/16/91
317C2	FF	1.3	1.7/8	0.003	NSPS, Short, NLBHW, ILRM (on)	1/22/93
315C7	FF	1.8	1.8	0.003	NSPS, Short, NLBHW, ILRM (on)	4/16/91
315C6	FF	1.8	1.8	0.003	NSPS, Short, NLBHW, ILRM (off), B	4/16/91
315C4	FF	1.8	1.8	0.007	NSPS, Short, NLBHW, ILRM (on)	4/16/91
405C6	ESP	460	450	0.007	Short, NLBHW, CMBM	12/17/90
309C6	MC/ESP			0.010	NLBHW	7/1/96
316C1	FF	1.2\1.2	1.5\1.5	0.011	NSPS, Short, NLBHW, CMBM	3/25/92
405C4	ESP	460	450	0.011	Short, NLBHW, B, CMBM	8/1/95
316C2	FF	1.2\1.2	1.5\1.5	0.013	NSPS, Short, NLBHW, CMBM	3/25/92
406B4	ESP	340	450	0.016	NLBHW, Short	8/1/92
306C1	MC/FF	1.8	1.9	0.017	NLBHW	5/1/93
405C5	ESP	460	450	0.017	Short, NLBHW, CMBM	12/17/90
406B2	ESP	340	450	0.017	NSPS, Short, NLBHW, CMBM	8/1/87
406C1	ESP	340	450	0.019	NSPS, Short, NLBHW, CMBM	8/1/92
406C3	ESP	340	450	0.020	NSPS, Short, NLBHW, CMBM	8/1/95
406C4	ESP	340	450	0.021	NSPS, Short, NLBHW, CMBM	8/1/95
308C1	ESP	860		0.021	NLBHW	8/21/92
309C2	MC/ESP	480	710	0.023	NLBHW	10/1/92
309C1	MC/ESP	480	710	0.026	NLBHW	10/1/92
301C1	FF	1.2	1.7	0.026	Short, NLBHW, ILRM (on)	5/1/93
315C7	FF	2.1	1.9	0.026	NSPS, Short, NLBHW, ILRM (on), BPM	4/16/91
315C2	FF	2.1	1.9	0.033	NSPS, Short, NLBHW, ILRM (on), BPM	7/15/92
469C1	ESP			0.034	NLBHW, Nor	1/31/90
315C1	FF	2.1	1.9	0.035	NSPS, Short, NLBHW, ILRM (on), BPM	7/15/92
405C1	ESP	460	450	0.036	Short, NLBHW, CMBM, High LVM ND	8/1/92
301C3	FF	1.2	1.7	0.038	Short, NLBHW, ILRM (on)	5/1/93
315C5	FF	2.1	1.9	0.041	NSPS, Short, NLBHW, ILRM (on), BPM	4/16/91
301C3	FF	1.7	4.7	0.041	Short, NLBHW, ILRM (on), BPM	5/1/93
406C9	ESP	340	450	0.041	NSPS, Short, NLBHW, CMBM	8/1/87
406B3	ESP	340	450	0.046	NSPS, Short, NLBHW, CMBM	8/1/95
315C6	FF	2.1	1.9	0.050	NSPS, Short, NLBHW, ILRM (off), BPM, B	4/16/91
315C4	FF	2.1	1.9	0.052	NSPS, Short, NLBHW, ILRM (on), BPM	4/16/91
406C8	ESP	340	450	0.067	NSPS, Short, NLBHW, CMBM	4/25/88
406B1	ESP	340	450	0.069	NSPS, Short, NLBHW, CMBM	8/1/87
405C3	ESP	460	450	0.154	Short, NLBHW, Nor, CMBM, EFS	9/17/90
301C1	FF	1.7	4.7	0.207	Short, NLBHW, ILRM (on), BPM, EFS	5/1/93

TABLE 4-4. PM EMISSIONS FROM CEMENT KILNS IN NSPS FORMAT

EPA Cond ID	NSPS Site	PM Emissions (Cond Avg)		HW Burning Status	Kiln Type
		Gas Conc. gr/dscf*	NSPS Format kg PM/Mg dry raw meal		
317C2	x	0.003	0.0049	No	dry short
320C3	x	0.002	0.0061	Yes	dry long
317C3	x	0.002	0.0065	No	dry short
317C1	x	0.002	0.0075	No	dry short
200C5		0.002	0.0091	Yes	wet
321C3	x	0.005/0.004	0.0110	Yes	dry short
321C3	x	0.005/0.004	0.0110	Yes	dry short
205C5		0.002	0.0114	Yes	wet
205C6		0.003	0.0124	Yes	wet
206C9	x	0.003	0.0129	Yes	wet
315C2	x	0.001/0.033	0.0159	No	dry short
404C2		0.004	0.0192	Yes	wet
315C1	x	0.001/0.035	0.0192	No	dry short
200C4		0.004	0.0202	Yes	wet
405C6		0.007	0.0208	No	dry short
323C9		0.005	0.0212	Yes	wet
320C1	x	0.003	0.0227	Yes	dry long
404C4		0.004	0.0244	Yes	wet
315C7	x	0.003/0.026	0.0248	No	dry short
305C5		0.010	0.0256	Yes	dry long
316C1	x	0.011	0.0268	No	dry short
315C5	x	0.003/0.052	0.0290	No	dry short
316C2	x	0.013	0.0307	No	dry short
305B3		0.008	0.0324	Yes	dry long
315C6	x	0.003/0.05	0.0329	No	dry short
405C4		0.011	0.0331	No	dry short
204B2		0.008	0.0335	Yes	wet
206C6	x	0.009	0.0349	Yes	wet
207C3		0.007	0.0356	Yes	wet
206C7	x	0.008	0.0367	Yes	wet
335B1		0.012	0.0399	Yes	dry long
404C1		0.007	0.0401	Yes	wet
321C5	x	0.018/0.011	0.0415	Yes	dry short
205C8		0.009	0.0434	Yes	wet
406B2	x	0.017	0.0459	No	dry short
406B4	x	0.018	0.0466	No	dry short
323B1		0.012	0.0466	Yes	wet
206C8	x	0.010	0.0468	Yes	wet
315C4	x	0.007/0.052	0.0480	No	dry short
405C5		0.017	0.0485	No	dry short
323C8		0.014	0.0500	Yes	wet
306C1		0.017	0.0513	No	dry long
406C3	x	0.020	0.0543	No	dry short
406C1	x	0.020	0.0552	No	dry short

TABLE 4-4. PM EMISSIONS FROM CEMENT KILNS IN NSPS FORMAT

EPA Cond ID	NSPS Site	PM Emissions (Cond Avg)		HW Burning Status	Kiln Type
		Gas Conc. gr/dscf*	NSPS Format kg PM/Mg dry raw meal		
406C4	x	0.021	0.0572	No	dry short
303C6	x	0.017	0.0574	Yes	dry short
320C5	x	0.014	0.0575	Yes	dry long
208C1		0.014	0.0580	Yes	wet
305B2		0.023	0.0584	Yes	dry long
322C8		0.013	0.0596	Yes	wet
201C1	x	0.011	0.0601	Yes	wet
404C5		0.012	0.0621	Yes	wet
208C2		0.016	0.0633	Yes	wet
681C1		0.014	0.0651	Yes	wet
301C1		0.01/0.04/0.21	0.0697	No	dry short
203C5	x	0.009	0.0708	Yes	wet
200C1		0.013	0.0723	Yes	wet
208C3		0.017	0.0751	Yes	wet
303C1	x	0.023	0.0758	Yes	dry short
308C1		0.021	0.0768	No	wet
302C3		0.060	0.0781	Yes	wet
228C6		0.026	0.0784	Yes	wet
309C2		0.023	0.0784	No	dry long
301C3		0.03/0.04/0.04	0.0793	No	dry short
207C2		0.018	0.0800	Yes	wet
335C1		0.023	0.0800	Yes	dry long
303C7	x	0.025	0.0806	Yes	dry short
303C2	x	0.024	0.0847	Yes	dry short
302C4		0.050	0.0864	Yes	wet
323B2		0.020	0.0865	Yes	wet
204B3		0.012	0.0867	Yes	wet
228C2		0.013	0.0890	Yes	wet
335B2		0.030	0.0905	Yes	dry long
681C2		0.015	0.0927	Yes	wet
309C1		0.026	0.0941	No	dry long
405C1		0.036	0.0948	No	dry short
203C1	x	0.014	0.0956	Yes	wet
300C3		0.013	0.0962	Yes	wet
321C1	x	0.06/0.04	0.0963	Yes	dry short
202C1		0.022	0.0997	Yes	dry long
204C1		0.034	0.1008	Yes	wet
403C4		0.013	0.1041	Yes	wet
203C6	x	0.015	0.1049	Yes	wet
203C2	x	0.018	0.1078	Yes	wet
406C8	x	0.067	0.1083	No	dry short
302C2		0.061	0.1097	Yes	wet
335C6		0.035	0.1107	Yes	dry long
406C9	x	0.041	0.1109	No	dry short

TABLE 4-4. PM EMISSIONS FROM CEMENT KILNS IN NSPS FORMAT

EPA Cond ID	NSPS Site	PM Emissions (Cond Avg)		HW Burning Status	Kiln Type
		Gas Conc. gr/dscf*	NSPS Format kg PM/Mg dry raw meal		
323C1		0.022	0.1124	Yes	wet
680C1		0.018	0.1145	Yes	wet
207C1		0.028	0.1158	Yes	wet
406B3	x	0.046	0.1167	No	dry short
302C1		0.034	0.1171	Yes	wet
204C9		0.024	0.1174	Yes	wet
206C5	x	0.029	0.1189	Yes	wet
323B3		0.026	0.1189	Yes	wet
322C1		0.019	0.1195	Yes	wet
335C8		0.028	0.1196	Yes	dry long
322C3		0.024	0.1196	Yes	wet
201C2	x	0.024	0.1283	Yes	wet
204B4		0.025	0.1295	Yes	wet
206C1	x	0.023	0.1301	Yes	wet
203C4	x	0.016	0.1370	Yes	wet
403C2		0.031	0.1416	Yes	wet
202C2		0.031	0.1457	Yes	dry long
403C1		0.029	0.1486	Yes	wet
200C2		0.023	0.1514	Yes	wet
401C4		0.041	0.1638	Yes	wet
406B1	x	0.069	0.1830	No	dry short
401C1		0.048	0.2015	Yes	wet
401C3		0.049	0.2150	Yes	wet
402C1		0.033	0.2162	Yes	wet
228C7		0.069	0.2202	Yes	wet
305C1		0.063	0.2249	Yes	dry long
202C6		0.046	0.2312	Yes	dry long
404C3		0.041	0.2357	Yes	wet
403C3		0.029	0.2426	Yes	wet
305C3		0.077	0.2499	Yes	dry long
335C9		0.071	0.2883	Yes	dry long
201C3	x	0.056	0.2905	Yes	wet
305C6		0.113	0.2924	Yes	dry long
300C6		0.023	0.2973	Yes	wet
491C1		0.063	0.3201	Yes	wet
202C5		0.032	0.3397	Yes	dry long
205C1		0.050	0.3477	Yes	wet
401C5		0.077	0.3504	Yes	wet
305C2		0.080	0.3979	Yes	dry long
335C7		0.094	0.4414	Yes	dry long
402C5		0.085	0.5061	Yes	wet
300C1		0.071	0.5185	Yes	wet
300C7		0.044	0.5384	Yes	wet
405C3		0.154	0.5613	No	dry short

TABLE 4-4. PM EMISSIONS FROM CEMENT KILNS IN NSPS FORMAT

EPA Cond ID	NSPS Site	PM Emissions (Cond Avg)		HW Burning Status	Kiln Type
		Gas Conc. gr/dscf*	NSPS Format kg PM/Mg dry raw meal		
472C1		0.100	0.9021	Yes	wet
472C2		0.900	8.6081	Yes	wet

* main / bypass stack measurement

TABLE 4-5. LWAK PM

EPA Cond ID	APCS	FF A/C	PM Cond Avg (gr/dscf)	Summ Comments	Cond Date	SVM SRE %
224C2	FF	1.5	0.001	NLBHW	8/1/96	99.92
225C2	FF	1.5	0.001		8/1/96	100.00
225C1	FF	1.5	0.001		8/1/93	100.00
227C1	FF	2.8	0.001		1/1/94	100.00
226C2	FF	1.7	0.002		8/26/97	99.98
226C1	FF	1.7	0.002		7/1/93	100.00
336C3	FF	1.8	0.002		5/1/95	NA
314C3	FF	1.4	0.003		3/18/96	99.99
475C1	FF	4.5	0.003		6/23/93	99.99
474C1	FF	1.5	0.003		9/1/94	99.99
223C1	FF	1.2	0.004		8/1/93	100.00
224C1	FF	1.5	0.005		8/1/93	99.98
311C1	FF	1.9	0.006		8/8/92	99.86
307C4	FF/VS	4.4	0.007		12/1/92	99.99
313C1	FF	1.4	0.007		8/8/92	99.90
336C2	FF	1.8	0.007		3/24/94	NA
336C1	FF	1.8	0.008		3/24/94	NA
307C1	FF/VS	4.4	0.008		12/1/92	99.99
608C1	FF	NA	0.010		3/1/96	99.99
312C1	FF	1.8	0.010		8/8/92	99.91
307C2	FF/VS	4.4	0.010		12/1/92	99.99
310C2	FF	3.6	0.012		8/16/95	99.98
312C2	FF	1.8	0.013		5/1/95	NA
479C1	FF/VS	NA	0.016	Nor, pre-BIF	8/1/90	NA
479C2	FF/VS	NA	0.017	B, pre-BIF	8/1/90	NA
310C1	FF	3.6	0.018		8/12/92	99.98
476C1	FF	1.3	0.020	Nor	2/1/93	99.85
307C3	FF/VS	4.4	0.022		12/1/92	99.99
314C1	FF	1.4	0.025		8/8/92	99.74

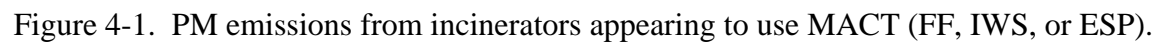
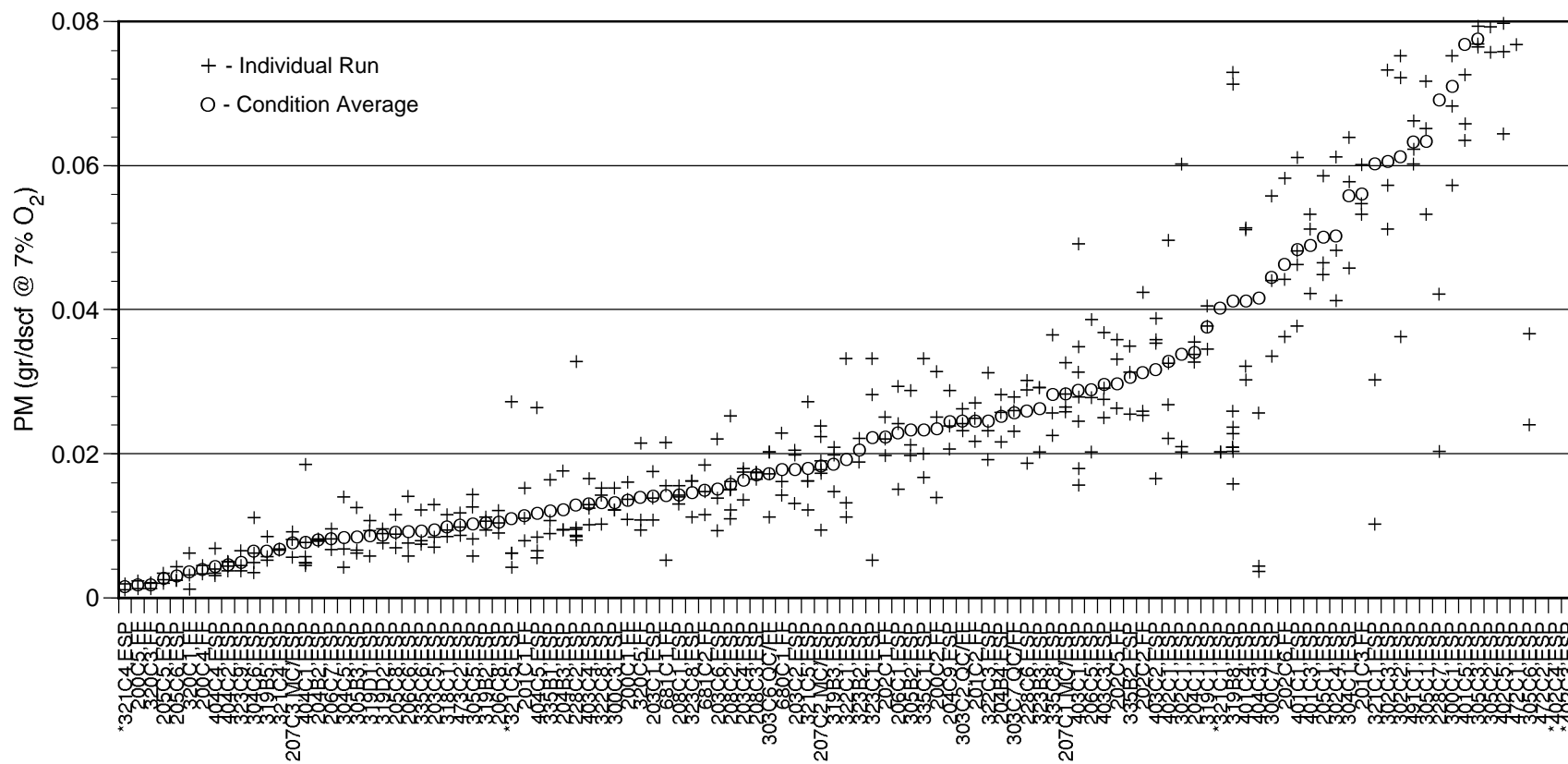


Figure 4-1. PM emissions from incinerators appearing to use MACT (FF, IWS, or ESP).



*: Bypass stack measur.

Figure 4-2. Cement kiln PM emissions.

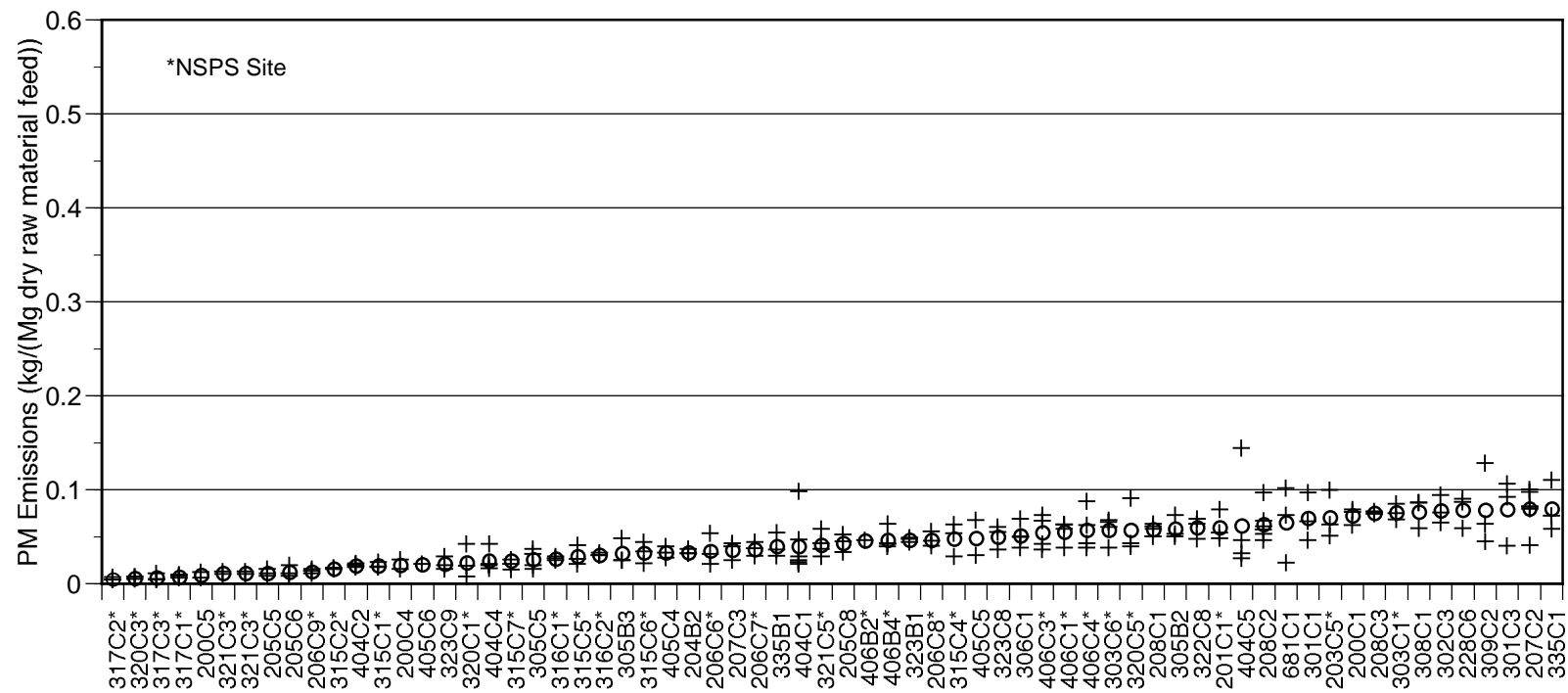


Figure 4-3. Cement kiln PM emissions in NSPS format (1 of 2).

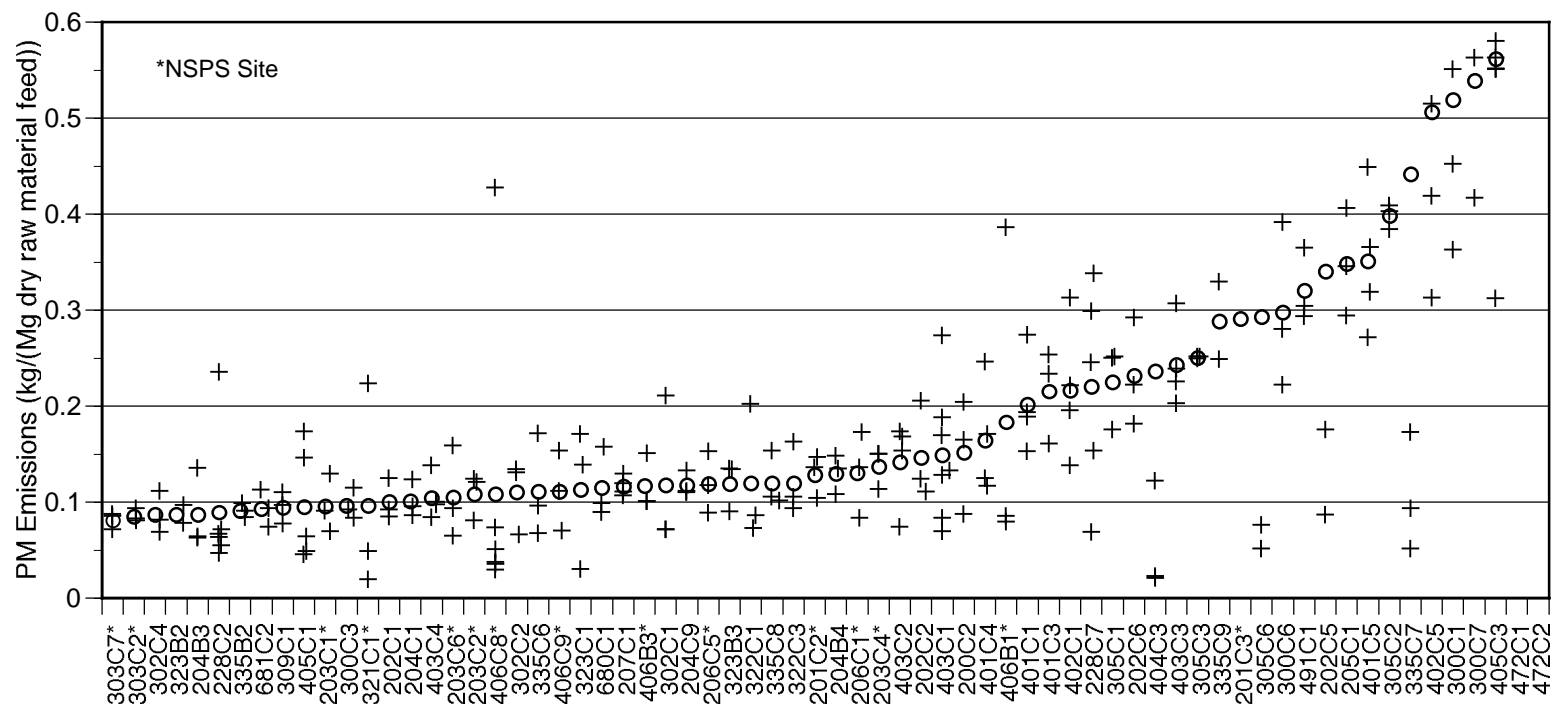


Figure 4-3. Cement kiln PM emissions in NSPS format (2 of 2).

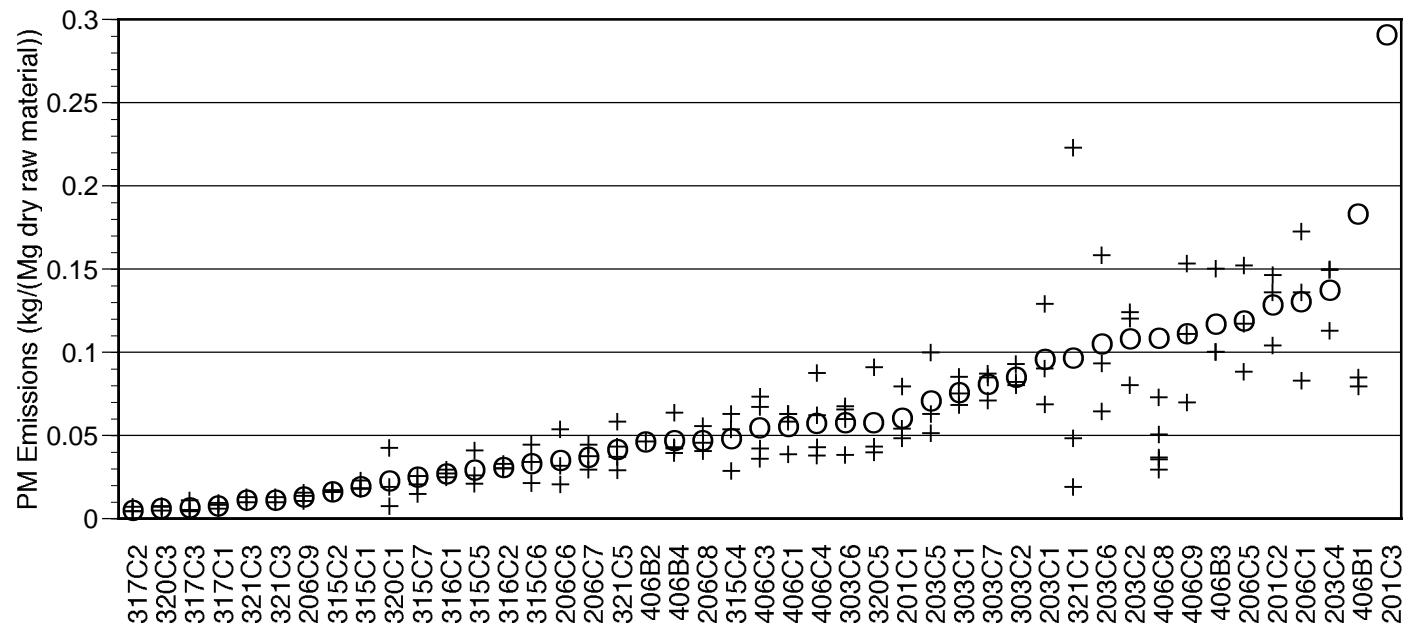


Figure 4-4. PM emissions from cement kilns under the NSPS.

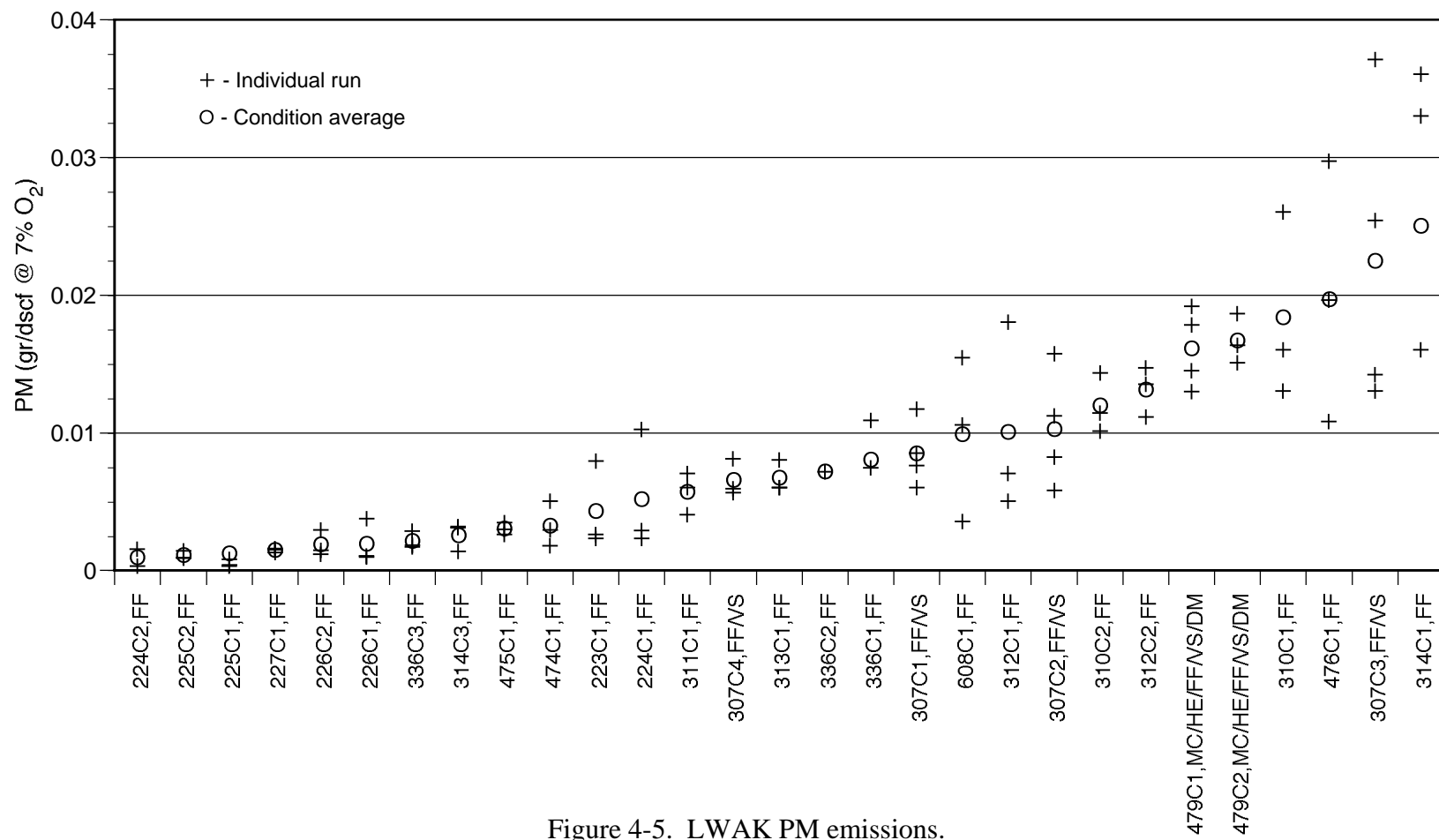


Figure 4-5. LWAK PM emissions.

CHAPTER 5

CARBON MONOXIDE AND HYDROCARBONS

Carbon monoxide (CO) and hydrocarbons (HC) are used as surrogate indicators for the control of organic products of incomplete combustion (PICs) that are HAPs (non-PCDD/PCDF organic HAPs specifically). Rationale for the use of limits on CO or HC is described in Chapter 12 of this document.

5.1 INCINERATORS

CO emissions from HWIs are currently limited under RCRA incinerator regulations to less than that occurring in a successful trial burn destruction and removal efficiency (DRE) demonstration. HC are not directly limited under current RCRA incinerator regulations, although they may be limited in some cases under omnibus authority, typically to levels based on the current RCRA BIF regulations.

The relationship between CO and HC emissions for hazardous waste incinerators is shown in Figure 5-1, based on trial burn data given in Table 5-1. CO and HC levels are directly related (and both high) under poor combustion conditions. At CO levels of less than about 100 ppmv, there is no apparent relationship between CO and HC, except that when CO is low, HC are almost always low as well. This supports the position that CO is usually a very conservative indicator for assuring good combustion conditions. However, there are cases for certain types of incinerators where CO can be high while HC levels are low, as discussed further below. Based on these considerations, compliance for non-PCDD/PCDF organic HAPs may be demonstrated by meeting either the CO or HC MACT standard on a continuous basis (i.e., through use of a continuous emissions monitor), as developed below. If continued compliance with CO is chosen, a one-time demonstration that HC emissions are also below the MACT standard must be made.

Note that almost all of the CO and HC emissions data that are available from incinerators are reported as a trial burn “run average” (RA) -- i.e., the average level of the CO/HC CEM

measurement over each individual run, which is typically a 1 to 3 hour period. Alternatively, compliance with the MACT standard is required with a continuous emissions monitoring system on a “maximum hourly rolling average” (MHRA) basis, updated every minute. Nonetheless, the trial burn run average data are used to set the MACT standards because:

- The run average data are taken from trial burn testing done under worst case combustion conditions. Results of the trial burn are used to directly set permit limits on CO/HC, as well as other indirect indicators of adequate combustion practices. Facilities must then comply with these permit limits on a continuous basis. Thus, these levels should be reasonably achievable in subsequent day-to-day operations on a continuous basis.
- There is very little “maximum hourly rolling average” data available (15 CO conditions and 9 HC conditions). Some of the proposed rule and May 1997 NODA conditions that were apparently MHRA’s have since been determined to instead be maximum instantaneous (less than 15 second usually) levels, and thus removed from consideration in setting the MHRA based floors.
- Some limited hazardous waste incinerator testing data discussed and presented in more detail below indicate that often there is not a significant difference between the MHRA and RA data and that the final rule standards of 100/10 ppmv for CO/HC are reasonably achievable on an MHRA basis.
- Long term CO/HC emissions data (over days or months) are not necessary to evaluate the CO/HC MACT standards, even though the CO/HC MACT standards are a CEMS compliance based standard. This is because 1 to 3 hour snapshots of the CO/HC performance behavior from worst case trial burn conditions from many different incinerator types and wastes are adequate to determine CO/HC emissions standards that are reasonably achievable on a continuous long-term basis.

CO and HC are controlled from HWIs by maintaining good combustion design, operating, and maintenance practices (GCP-D/O/M), some of which may include:

- Stoichiometric fuel/air ratio -- Providing adequate excess oxygen with use of oxygen CEM and feedback air input control.
- Combustion air distribution -- Providing adequate fuel and air mixing.

- Waste fuel quality -- Blending or size reduction of wastes and fuels to minimize combustion “spikes”. This may also involve the use of supplemental clean burning fuels.
- Waste batch size and/or volatility -- Controlling batch size or volatile content to minimize combustion “spikes”.
- Waste characterization -- Acquire sufficient knowledge of waste (and supplementary fuel) characteristics which are important to achieving proper system combustion operations, such as waste heating value, liquid waste viscosity, waste chlorine content, etc. This will involve periodic waste analysis as determined necessary based on history and knowledge of waste streams that are burned.
- Residence time and temperature -- Maintaining high temperature and adequate flue gas residence time at temperature.
- Liquid atomization -- Maintaining adequate liquid atomization based on monitoring ratio of atomizing media to liquid waste flow, differential liquid pressures, liquid viscosity, flame appearance, etc.
- Operation and maintenance -- Operation of the facility by qualified operators. Also, periodic maintenance of burners and fuel and supply lines and injection nozzles to the recommended standards.
- Afterburning -- Use of combustion gas afterburning, for example as typically done in rotary kiln hazardous waste incinerators.

5.1.1 Existing Sources Floor

Based on the best-performing CO and HC sources, as shown in Table 5-1, MACT for HC and CO is defined for existing sources as the GCP-D/O/M practices discussed in the previous paragraph. As in the May 1997 NODA and proposed rule, it has not been attempted to quantify the GCP-D/O/M practices used by the best-performing facilities. This would be of limited use in evaluating the floor level achievable with the use of GCP-D/O/M without a detailed evaluation of each test condition. It would also require information that is not readily available for many facilities. Instead, the floor levels are based on an engineering evaluation of the HC and CO levels being achieved by well operated, maintained, and designed HWI facilities that are currently operating.

Carbon Monoxide (CO)

Table 5-1 summarizes CO run average (RA) and CO maximum hourly rolling average (MHRA) test condition data from HWIs. CO (RA) is available from over 75 facilities and ranges widely from 0.3 to 10,000 ppmv. CO (MHRA) is available from about 15 facilities and ranges from 5 to 500 ppmv.

CO (RA) levels are shown in Figure 5-2. The best performing sources have levels below 10 ppmv. A CO MACT floor level of 100 ppmv is based on:

- A wide range of different hazardous waste combustor designs (including rotary kilns, liquid injection, fluidized bed, and fixed hearth controlled air types), operations (e.g., batch modes, continuous feed, etc.), waste types (solids, sludges, liquids, gases), and waste constituents (e.g., high, medium, and low combustibles) are represented in the set of facilities achieving CO levels less than 100 ppmv. Thus, this level is representative of good combustion in a variety of facilities using well designed and operated combustion equipment under stressed, worst case, trial burn operating conditions.

Note that for certain types of waste combustors and waste streams (in particular, submerged rapid quench types burning aqueous wastes), CO levels of less than 100 ppmv may be difficult to meet. However, for these incinerators, the alternative of meeting a HC floor level of 10 ppmv is readily achievable, as discussed below in the next section. Thus, subcategorization of incinerators for CO/HC is not needed.

- As shown in Table 5-2, from a previous EPA-sponsored testing series on hazardous waste incinerators, 7 of 8 hazardous waste incinerators (spanning a range of incinerator types and wastes) have both run average and maximum hourly rolling average CO emissions less than 100 ppmv (Trenholm et al., 1984). The one facility that had CO levels of greater than 600 ppmv also had HC of about 50 ppmv, indicating poor non-MACT like combustion conditions from this facility. Therefore, run average data are reasonably adequate indicators of maximum hourly rolling average achievable levels. Further support for the use of run average data is the similarity of run average and maximum hourly rolling average data from both: (1) simultaneous measurements at CK and LWAKs, as shown in Tables 5-3, 5-4, and 5-5; and (2) simultaneous measurements at the 15 incinerators in the Table 5-1 with both MHRA and RA data.

- Over 60% of all of the conditions have CO levels less than 20 ppmv. Over 80% of all test conditions have levels less than 100 ppmv.
- There are about 20 different HWI conditions with CO levels above 100 ppmv. Characteristics of some of these facilities help explain why CO levels are higher than the floor of 100 ppmv and are not representative of MACT GCP-D/O/M:
 - Use of rotary kiln units that do not have afterburners (Source ID Nos. 727, 809) and a multiple hearth unit without an afterburner (Source ID No. 332).
 - Use of rotary kiln units with apparently inadequately designed afterburners based on CO levels (Source ID Nos. 503, 359, 334, 808).
 - Use of a lower temperature fluidized bed unit (ID No. 806).
 - Use of liquid injection facilities with rapid combustion gas quenching (Source ID Nos. 707, 459, 805, 209, 477, 468, 463, 350, 460, 478). Note that certain proposed rule commenters have argued that their high temperature rapid-quench designed incinerator units cannot meet a CO level of 100 ppmv, although they consistently achieve DREs of greater than 99.99% and have low HC levels. Rapid quenching of the gases immediately after the flame combustion may act to “freeze” higher equilibrium levels of CO present at the high flame temperatures, and may not allow sufficient time for the oxidation of CO to CO₂, which is the final and slowest step in the hydrocarbon destruction process. These units may still be achieving complete waste combustion because in this case CO may not be entirely representative of hydrocarbon breakdown and destruction. CO is a conservative indicator of complete combustion. These types of facilities can meet the alternative HC standard discussed below.
 - Inadequate treatment of special/unique waste types such as:
 - Explosives and propellant wastes (Source ID Nos. 503, 727) which, due to rapid burning characteristics, may lead to incinerator “puffs” of CO. However, under proper system design, CO levels of less than 100 ppmv are readily achievable.

- Aqueous wastes (Source ID Nos. 707, 809, 805, etc.). Certain commenters argue that, with high water content wastes, CO levels are inflated due to: (1) the quenching of CO destruction reactions by dilution of the combustion gas with water vapor, and/or (2) the presence of water vapor leading to lower combustion temperatures and lower CO oxidation rates. The true impacts of these conjectured mechanisms are unclear. Nonetheless, for these types of facilities, compliance with the alternative HC limit may be required.
- “Outlier” condition data, for which the same units have other test conditions with CO levels much less than 100 ppmv (Source ID Nos. 915, 350, 477, 209, 460, 325, 806, 334).
- Poor combustion conditions as indicated by one or more simultaneous measured DREs of less than 99.99% (Source ID Nos. 334C2, 805C1, 727C2, 707C4, 463C1, 707C3, 707A6).
- Old testing data conducted before 1984 (Source ID Nos. 468C1, 460C1).
- “Outlier” individual run data. Many conditions have two runs with CO much less than 100 ppmv and one run with CO much greater than 100 ppmv (Source ID Nos. 350C1, 209C6, 325C1, 325C2, 808C1).
- CO emissions standards for other combustion sources further support that a CO level of 100 ppmv is reasonably achievable:
 - Waste incinerator standard for European Union of about 100 ppmv, based on a 30 minute averaging period.
 - Medical waste incinerator standard of 50 ppmv @ 7% O₂, based on a 12 hour averaging period.
 - Municipal waste combustor standard of 50 to 150 ppmv @ 7% O₂, based on a 4 to 24 hour period, depending on facility size and design.

Hydrocarbons

Table 5-1 also summarizes all HC (RA) and HC (MHRA) test condition data from HWIs. The HC (RA) data are from about 40 different sources and range from less than 1 to greater than 20 ppmv. HC (MHRA) data are only available from 9 conditions.

The HC data from incinerators are available from both “hot” (heated) and “cold” (unheated) flame ionization detector (FID) sampling and analysis systems. This is unlike the CK and LWAK HC data discussed below, all of which has been taken with heated FID as per the current BIF requirements. The sampling and analysis method that has been used is identified in the sixth column of Table 5-1. Known hot FID measurements are indicated with an “H”, known cold FID measurement are indicated with a “C”, and a “U” is used where it cannot be verified if the method was hot or cold.

The use of heated FIDs is required for compliance with the MACT standards since unheated FID HC measurements may be biased low compared with heated FID detectors. In unheated FIDs, semi-volatiles and soluble volatiles in the stack gas are potentially condensed out in the sampling line and water condenser/sample conditioner prior to entering the FID detector. Thus, to evaluate the MACT floor, it is most desirable to only use data known to be taken with heated FIDs. However, all data from all FID types are considered in setting the MACT floor because:

- Almost half of the HC data (50 test conditions from about 25 facilities) are taken from confirmed heated FIDs, as shown in Figure 5-3. Note that all but two test conditions are less than 10 ppmv, with most less than 3 ppmv.
- A smaller portion of the HC data are from unheated FID measurements (18 conditions from 6 facilities), as shown in Figure 5-4.
- The remainder (about 60 conditions) are from unconfirmed FID set-ups. Note that the vast majority of these have been reported to be taken using EPA Method 25A, which requires the use of a hot FID. However it cannot be confirmed from information in the available test report that the heated FID method was used. There are some reports that claim to use Method 25A while clearly using a cold FID.
- HC from incinerators usually consist primarily of volatile, non-condensable (very low concentrations), and non water-soluble HC species. Thus, there is typically not a major

difference between cold and hot FID measurements. Note that this is not to imply that unheated FID are adequate for compliance determination.

- Looking at the data as a whole, the cold FID data and unknown method data do not generally appear to be biased low compared with the hot FID data.

All HC data from all different types of FIDs are shown in Figure 5-5. The floor is set at 10 ppmv, based on various considerations:

- As discussed for CO, a wide range of different hazardous waste combustor designs (including rotary kilns, liquid injection, and fixed hearth controlled air types), operations (e.g., batch modes and continuous feed), waste types (solids, sludges, liquids, gases), and waste constituents (e.g., high, medium, and low combustibles) are represented in the set of facilities achieving HC levels less than 10 ppmv. Thus, this level is representative of good combustion in a variety of facilities using well designed and operated combustion equipment under stressed, worst case trial burn operating conditions.
- A recent EPA-sponsored testing program involved comprehensively speciating PICs from a hazardous waste incinerator that is operating with HC levels near the proposed rule standard of 12 ppmv (or at least greater than 5 ppmv). The first step of this program was to identify a candidate incinerator that met this criteria. This was difficult, as almost all of the facilities with trial burn HC emission levels in this range indicated that these levels are not representative of current operations (i.e., they now have HC less than 5 ppmv). Some reasons given to the reduced HC levels include:
 - Initial HC levels were artificially biased high because of the detection of non-combustion related HC from organics contained in surfactants used in wet scrubber liquids that are released into the flue gas during the scrubbing process. The surfactants are additives used to prevent the buildup and growth of algae and other bacteria in scrubber liquids. The elimination or replacement of these organic scrubber additives has led to reduced HC emissions levels.
 - Combustion improvement related upgrades, such as improved combustion burners, better waste/air mixing, more frequent burner cleaning, etc.
 - Inaccurate original HC CEMS readings.

The facilities with HC greater than 3 ppmv that were considered candidates for PIC testing were rotary kilns that did not use afterburners, which is not conventional practice and not considered MACT-like using GCP-D/O/M. The other potential sites were specialized explosives and propellant popping furnaces.

Also of note is preliminary evaluation testing done as part of the same PIC evaluation program. Attempts were made on a commercial rotary kiln incinerator to generate HC emissions greater than 5 ppmv. This involved various procedures to intentionally disrupt the combustion process, including modifying the degree of liquid waste atomization, operating at both very high and very low levels of excess oxygen, varying waste feedrates, varying combustion temperatures, water quenching portions of the incinerator, etc. However, with respect to HC emissions, the incineration process was extremely robust, and it was not possible to reasonably generate HC emissions greater than 3 ppmv.

- As shown in Table 5-2 discussed above for CO, in a previous EPA-sponsored testing series on hazardous waste incinerators, 7 of 8 hazardous waste incinerators (spanning a range of incinerator types and wastes) had hot FID measured HC emissions less than 5 ppmv (Trenholm et al., 1984). Note that the one facility that had HC of about 50 ppmv also had CO levels of greater than 600 ppmv, indicating poor non-MACT-like combustion conditions.
- Only two of the facilities with hot FID measurements have HC levels greater than 10 ppmv.
- Over 85% of all the HC condition measurements are less than 10 ppmv, with almost 75% less than 5 ppmv.
- HC emissions data from other combustion sources further support that 10 ppmv is a representative indicator of good combustion conditions, including that of hazardous waste boilers (all of which have HC levels below 10 ppmv) and municipal waste combustors.
- There are 13 test conditions from 7 different facilities that have HC averages greater than 10 ppmv. These are not considered representative of MACT control (GCP-D/O/M) due to reasons including:
 - ID No. 727C1 and C2 -- Combustion device is a rotary kiln without an afterburner (secondary combustion chamber). This is not standard practice, as well designed rotary kiln incinerators use afterburners to control organic emissions. Also, the unit

is burning highly volatile explosive-containing (TNT) wastes, which can be difficult to burn efficiently in a rotary kiln (due to high volatility and oxygen requirements) without the use of combustion gas afterburning. High CO and HC emissions levels, as well as some POHC DRE less than 99.99%, are also direct indicators of incomplete combustion taking place during testing condition 2. Note that there is one outlier run within condition 1. The condition 1 median is 8 ppmv, indicating that 10 ppmv can be achieved even by this unit under certain conditions.

- ID No. 806C2 -- This condition has a single high outlier run which is inflating the test condition average. The other two individual test runs are both less than 10 ppmv. Additionally: (1) the test condition has correspondingly high CO levels, further indicating inefficient combustion conditions; (2) this unit has another test condition with a HC average less than 10 ppmv and a CO level of about 60 ppmv (806C1); and (3) the unit is a fluidized bed that operates at lower than typical combustion temperatures and is not necessarily representative of MACT combustion practices.
- ID No. 726C1 -- The trial burn test report conjectures that there was likely contamination in the HC CEMS sampling line and system during the tests of this condition. This is confirmed through subsequent HC CEMS sample line purge and cleaning and follow-up HC testing under another condition 726C2, where HC levels were demonstrated to be much less than 10 ppmv.
- ID No. 503C3-7 -- The reported HC levels are maximum instantaneous values (as opposed to integrated run averages) and thus are not directly representative or appropriate for basing one-hour rolling average MACT standard on. Additionally, (1) the unit is a low temperature rotary kiln (900°F) with a very low temperature afterburner (1400°F) and thus is potentially not representative of good combustion practices, and (2) it is burning explosive propellant wastes.
- ID No. 460C3 -- Has two other test conditions with HC less than 10 ppmv (460C1 and C2). Also, the HC measurement is suspect because the corresponding CO measurement for the high-HC condition was very low.

5.1.2 New Sources Floor

The definition of MACT for new sources is based on the use of good combustion practices and is the same as that for existing sources. The control measures used by the best controlled source are not differentiable from those used by the best 6% of sources. The MACT floor levels for new sources for CO and HC are thus the same as for existing sources -- CO of 100 ppmv and HC of 10 ppmv.

5.2 CEMENT KILNS

Long-type kilns that are not set up to make mid-kiln bypass measurements are currently required under the EPA RCRA BIF regulations to:

- Control CO in the main stack to less than 100 ppmv with no limit on HC; or
- Control HC in the main stack to less than 20 ppmv with a site specific limit on CO as that demonstrated during the test.

Cement kilns with bypasses (short-type preheater and preheater/precalciner alkali bypass arrangements, and mid-kiln bypass sampling configurations on two long kilns) can currently monitor the bypass gas to comply with either:

- Control of CO in the bypass to less than 100 ppmv with no limit on HC; or
- Control of HC in the bypass to less than 20 ppmv with no limit on CO.

Note that for kilns with bypasses, there is no current regulatory requirement for controlling main stack emissions of either CO or HC. Therefore, there is no associated MACT floor at the main stack for either CO or HC for existing bypass kilns.

5.2.1 Existing Sources

Main Stack

Hydrocarbons -- Table 5-3 summarizes HC (RA) and HC (MHRA) main stack gas emissions from CKs. HC (MHRA) condition averages range from 5 to 100 ppmv. HC stack gas levels may be due to HC generation from both the main flame and waste combustion and from low

temperature desorption from raw materials as they heat up in the counter-current CK operation. Thus, HC in the main stack are currently controlled through the use of good combustion practices at the main flame burner and waste combustion locations, use of raw materials that are low in organic content, and/or increased back end kiln temperature to control raw material desorbed organics.

The definition of MACT for HC in CKs ideally may include the use of raw materials with low organics content and/or combustion related parameters of the main flame burner and waste combustion locations. However, as was done in the proposed rule and the May 1997 NODA, the definition of MACT and screening of the universe to identify the sources using MACT were not performed for CO and HC at the main stack because: (1) it is not the intent of the HWC MACT rule to adversely influence the use and selection of available raw materials at existing hazardous waste burning cement kilns; and (2) inability to evaluate (incomplete information) waste combustion related system characteristics. The HC floor at the main stack for existing sources is set at the current EPA RCRA BIF standard of 20 ppmv.

Note that almost all of the cement kilns are able to comply with the current HC BIF standard of 20 ppmv, based on the BIF trial burn compliance tests contained in the EPA HWC emissions database. However, the database contains some facilities with levels above the 20 ppmv standard. This is because, under the original BIF rule, a site-specific “Tier III” HC limit was allowed where HC emissions could exceed 20 ppmv. Under this compliance option it had to be demonstrated that the HC emissions levels were not increased by the addition of burning hazardous wastes compared with baseline non-hazardous waste burning HC levels. However, subsequent litigation removed this option provided in the original BIF rule. Since these BIF trial burn compliance tests, the five kilns that were unable to meet the HC limit of 20 ppmv have all taken steps to reduce their HC emissions below the 20 ppmv BIF standard by raw material substitution of the problematic feed stream(s), improved combustion at the hot end, or addition of a mid-kiln bypass monitoring system.

Specifically, the 5 kilns which initially made Tier III alternate HC limit requests included Lafarge Paulding (Source ID No. 302), Lafarge Alpena (No. 320), Lonestar Greencastle IN (No. 304), Ash Grove Chanute (No. 402), and Holnam Clarksville (No. 204):

- Kilns Nos. 402 and 204 have since installed mid-kiln sampling systems for compliance with HC/CO standards.

- Kiln No. 302 has reduced HC emissions from initial CoC levels greater than 60 ppmv to 17 to 18 ppmv by substituting clay raw materials with flyash and foundry sand, as noted in initial and subsequent CoC testing reports contained in the EPA database.
- Kiln No. 304 has also reduced initial CoC HC emissions levels to less than 20 ppmv through a change in raw materials, as noted in Jan. 9, 1997 letter from Craig Campbell (CKRC) to Frank Behan (EPA/OSW). HC reductions were initially achieved through higher back end temperature operation. However, due to subsequent elevated PCDD/PCDF levels, raw materials substitution was made.
- Kiln No. 320 has reduced original main stack CoC HC levels to less than 20 ppmv, based on CoC and re-CoC testing, presumably with a combination of raw materials substitution and/or higher back end temperature operation.

Note also that kilns at Continental Hannibal (No. 319) and Holnam Holyhill (Nos. 205/206) also showed interest in compliance with the Tier III limit. Both have HC emissions levels during CoC testing greater than 20 ppmv. However, both have since demonstrated compliance with the 20 ppmv (or CO) limit, presumably again through raw materials substitution and/or kiln operational modification.

Carbon Monoxide -- Table 5-3 summarizes CO (RA) and CO (MHRA) levels from hazardous waste burning CKs. CO (MHRA) condition average levels range widely, from 50 to 3,000 ppmv. CO that is present in the flue gas at the CK main stack may be generated from conditions unrelated to the combustion efficiency of burning hazardous wastes and fuel at the hot-end main flame or mid-kiln location. This is because: (1) CO may be generated from the internal kiln process chemistry involving limestone calcination which produces high levels of CO₂ which dissociates at high temperature under “sintering” conditions; or (2) CO may be generated from low temperature evolution of organics in raw material feedstocks.

The MACT floor for CO for CKs at the main stack is set at the currently enforceable EPA RCRA BIF floor of 100 ppmv. Note that based on CoC testing results, five of the currently operating waste burning cement facilities are able to comply with the BIF CO standard of 100 ppmv during the CoC testing.

Note that, if choosing to comply with the CO standard on a continuous basis, a one-time demonstration of meeting the HC standard is required.

Bypass Stack (Alkali or Mid-kiln Bypass)

As mentioned previously, there are two types of “bypass” gas arrangements for waste burning cement kilns. Most preheater and preheater/precalciner arrangement cement kilns are equipped with “alkali” bypass ducts, where a portion (typically 5 to 30%) of the short kiln exhaust is diverted to a separate air pollution control device and, sometimes, to a separate stack. The gases are diverted to avoid the build-up of alkali metal salts that adversely affect the kiln operation. Alternatively, some long kilns have added a “mid-kiln” bypass, where a kiln gas sample is taken directly from the middle of a long kiln, usually just downstream of the cement “calcining” zone.

In each of these cases, unlike the main stack gas, the bypass gas HC and CO levels are generally directly representative of the kiln waste combustion process efficiency. They are certainly not affected by CO generated from raw materials desorption at low temperature and resulting evolution of unburned HC and CO, or CO formed from the high temperature calcination process, as the main stack may be:

- HC -- HC levels in the bypass are directly related to combustion efficiency. Elevated HC levels are a direct indicator of poor combustion efficiency usually due to kiln flame operation close to stoichiometric (with the presence of little or no excess oxygen in the gas) and/or poor fuel/air mixing.

Note that particularly for mid-kiln bypasses, there has been some potential concern over bypass HC levels being biased unrepresentatively low due to subsequent HC combustion that may take place when tempering air is used to rapidly quench the kiln bypass gas sample prior to the HC analyzer. However, HC measured in the bypass are a conservative measure of the combustion-generated HC present at the kiln exit:

- Because of the high quench rate in the bypass off-take, it has been shown that the time-at-temperature conditions in the main kiln flow are more likely to reduce HC than the elevated oxygen levels in the bypass gas off-take. This is supported further by the fact that CO levels in the main stack are usually much lower than those in the bypass.
- Simultaneous bypass and main stack HC measurements indicate a direct relationship between the two, differing by a constant level speculated to be the raw materials HC contribution.

- CO -- The CO level in the bypass is a highly conservative indicator of good combustion efficiency for cement kilns, particularly in mid-kiln bypass arrangements. Some demonstrations have shown that CO levels at the main stack are actually lower than CO levels at the bypass. This is because in the bypass, the rapid gas sample quenching limits the conversion of CO to CO₂ (which is a relatively slow reaction), whereas in the remaining kiln length, sufficient time-at-temperature conditions are available to fully oxidize CO.

Also, note that it is recommended, as in the current RCRA BIF regulation, that the bypass gas flow be at least 10% of the total gas flowrate. This is to ensure that the bypass gas flow is representative of the total gas flow. For kilns with alkali bypasses, this requirement is usually not a problem. However, for mid-kiln bypasses, it may not be feasible to take off this amount of sample gas volume flowrate. Lower bypass gas flowrates are allowed based on satisfactory demonstration that the bypass gas is fully representative of the total kiln fluegas.

There are two kilns with alkali bypasses that currently burn hazardous waste -- Source ID No. 303 (LoneStar Cape Girardeau) and Source ID No. 321 (Medusa Demopolis). There are also two long kilns -- Source ID Nos. 402 (Ash Grove Chanute) and 204 (Holnam Clarksville) -- that use a “mid-kiln” bypass. Thus, there are four CKs currently burning hazardous waste which use bypass stack gas measurements to comply with the current RCRA CO/HC requirements. Two of them currently comply with CO and the other two with HC.

Similar to the proposed rule, the May 1997 NODA, and current BIF requirements, bypass stack standards are set for both CO and HC. However, compliance can be achieved by meeting either one of the limits. Again, if choosing to comply with the CO standard on a continuous basis, a one-time demonstration of compliance with the HC standard is required.

MACT for CO and HC for CK bypasses is set based on that which is achievable using good combustion design, operating, and maintenance practices (GCP-D/O/M), similar to that previously done for incinerators. The good combustion practices discussed above for incinerators directly apply to the waste combustion practices in cement kilns. As in the May 1997 NODA and proposed rule (and for incinerators), it has not been attempted to quantify the GCP-D/O/M practices used by the best-performing facilities. Instead, the floor levels are based on an engineering evaluation of the HC and CO levels being achieved by well operated and designed facilities that are currently operating.

Carbon Monoxide -- Table 5-4 summarizes bypass stack measurement data for CO (RA) and CO (MHRA). CO (MHRA) ranges from 6 to 700 ppmv, considering all kilns. The MACT floor CO bypass level is set at 100 ppmv, based GCP-D/O/M and the following considerations:

- The CO bypass data from currently operating alkali bypass cement kilns ranges from 23 to 85 ppmv. Note that ID No. 303 complies with a HC limit, but has CO data less than 100 ppmv.
- Data from one wet kiln with a mid-kiln bypass (Source ID No. 204, Holnam Clarksville) ranges from 60 to 98 ppmv.

The other long wet kiln with a mid-kiln bypass (Source ID No. 402) has CO of 450 to 600 ppmv during CoC testing but, as discussed below, can meet the HC floor limit of less than 10 ppmv. Note that additional testing data submitted as part of the proposed rule would indicate that Source ID No. 402 can consistently meet CO levels of less than 200 ppmv.

- Two of the remaining four kilns that are not currently burning hazardous wastes have CO less than 100 ppmv. Of the two with data greater than 100 ppmv, both have HC levels of less than 10 ppmv, as discussed below.
- A level of 100 ppmv is consistent with the current EPA RCRA BIF bypass CK CO standard.
- A level of 100 ppmv is consistent with that determined to be representative of GCP-D/O/M for incinerators, which, although it is a different source category, is still appropriate due to similar combustion characteristics.

Hydrocarbons -- Table 5-3 also summarizes bypass stack data for HC (RA) and HC (MHRA). HC (MHRA) ranges from 0 to greater than 20 ppmv, considering all kilns. The MACT floor cement kiln HC bypass standard is set at 10 ppmv, based GCP-D/O/M and the following considerations:

- Most of the CK HC bypass measurements in the database are lower than 10 ppmv. This includes almost all of those that are currently burning hazardous waste.
- One of the long wet kilns with a mid-kiln bypass (ID No. 402) has CoC trial burn HC measurements of less than 7 up to 15 ppmv. Additional data are available from ID No. 402

testing, provided in the proposed rule comments from Ash Grove and Cadence, demonstrating that a HC level of 4 to 8 ppmv is readily achievable on an hourly rolling average basis at the bypass under good combustion conditions (where it was directly demonstrated that HC increases as CO increases).

The other long kiln with a mid-kiln bypass (ID No. 204) has limited data provided in the proposed rule comments. It shows that a HC level of less than 6 ppmv in the bypass is consistently achieved. It does not have CoC testing HC measurements, but does have CoC CO levels less than 100 ppmv, as discussed above.

- One of the two currently operating short alkali bypass kilns has HC measurements (Source ID No. 303, LoneStar Cape Girardeau). The CoC test results indicate that the HC levels, corrected to 7% O₂, are 0 (or near 0). The other alkali bypass kiln (Source ID No. 321) has CO levels less than 100 ppmv but no HC measurement data.
- All four of the bypass kilns that are no longer burning hazardous wastes have demonstrated bypass HC levels of less than 10 ppmv.
- A level of 10 ppmv is consistent with that determined representative of GCP-D/O/M for incinerators.

Note that proposed rule and the May 1997 NODA commenters mentioned that the HC level of 10 ppmv is not reasonably demonstrated for bypass kilns due to the very high level of oxygen dilution that is in the bypass gases (typically 15 to 19% O₂ by volume in the gases) as a result of the cooling of the bypass gases with ambient air addition. The actual HC levels in the bypass, after air dilution cooling, are very low and may be in the noise range of the HC FID measurement analyzer. In the case of ID No. 303, this level is 0.0, which remains as 0.0 even after correction to 7% O₂. Further communications from this facility indicate that 10 ppmv is achievable. However, there is concern about the validity of such low measurements based on analyzer measurement drift and accuracy and the ability to accurately correct for O₂. This is not a problem because:

- A HC analyzer span of 100 ppmv is currently required under BIF. HC analyzer accuracy is approximately $\pm 1\%$. Thus, the lower detection limit of a well operated and calibrated FID analyzer is about 1 ppmv. This can be readily improved by decreasing the span (e.g., to 50 ppmv of HC), if it can be demonstrated that 100 ppmv is not appropriate.

- Cement kiln bypass oxygen levels can be as high as 19%, resulting in a correction factor to 7% oxygen of about 7. Using a conservatively high detection limit measurement of 1 ppmv at 19% O₂ would be equal to about 7 ppmv @ 7% O₂, which is below the standard of 10 ppmv. Thus, compliance with 10 ppmv should not generally be impacted by analyzer detection limit measurements or oxygen dilution levels.
- Analyzer drift could potentially lead to false indications of non-compliance (i.e., drift of more than a few ppmv's may result in HC levels of greater than 10 ppmv). To avoid this, frequent analyzer calibrations, reduced span, and/or taking HC measurements upstream of the air dilution location may be required to avoid false indications of non-compliance.

5.2.2 New Sources Floor

Long Kilns

CO/HC MACT floor limits for new sources at existing cement production sites without bypass sampling systems are the same as those for existing sources, based on good combustion practices -- a main stack HC limit of 20 ppmv or CO limit of 100 ppmv.

Alternatively, for those newly constructed kilns at "greenfield" sites, an additional minimum HC level of 50 ppmv is required because of: (1) the inability of currently operating HW burning cement kilns to cost-effectively use raw materials substitution to reduce main stack HC levels, as mentioned above; (2) the flexibility of a new source to locate at a greenfield site where raw materials organics will not cause a problem with meeting the main stack HC standard; and (3) an identical requirement for new MACT rule for non-waste burning Portland cement kilns (see 64 FR 31898; June 14, 1999). Thus, the resulting MACT floor for greenfield kilns is either: a main stack HC limit of 20 ppmv; or CO limit of 100 ppmv and HC limit of 50 ppmv (also, a one-time demonstration of meeting a HC level of 20 ppmv is required if choosing the CO continued compliance option).

Kilns With Bypass Stacks

CO/HC MACT floor limits for new sources at existing cement production sites with bypass sampling systems are identical to those for existing sources at the bypass -- bypass stack HC limit of 10 ppmv or CO limit of 100 ppmv. For new sources at greenfield sites, the standard includes an additional requirement for a main stack HC level of 50 ppmv.

5.3 LIGHTWEIGHT AGGREGATE KILNS

LWAKs have RCRA BIF CO/HC standards identical to long cement kilns. LWAKs currently comply with either a CO limit of 100 ppmv or HC limit of 20 ppmv (and a site-specific CO limit that may be higher than 100 ppmv).

Identical to CKs, HC are controlled from LWAKs by maintaining combustion efficiency (good combustion practices) at the main flame waste burning location (to date, always in LWAKs at the hot end main flame), and/or utilizing raw materials low in organics content to prevent emissions from desorbed organics.

5.3.1 Existing Sources Floor

Hydrocarbons

Table 5-4 summarizes HC (RA) and HC (MHRA) emissions from LWAKs. HC (MHRA) levels range from 3 to 13 ppmv.

The best performing sources use good combustion practices to control HC. However, like incinerators and CKs, MACT has not been quantitatively defined. Note that Source ID No. 227 (Florida Solite), with the highest level of 13.1 ppmv, is no longer burning hazardous wastes.

The HC floor is set at 20 ppmv, based on that determined for cement kilns to be achievable through good combustion practices and that currently required under RCRA BIF regulations for LWAK and CKs. All currently operating LWAKs have been demonstrated to meet this level. Note that, in the May 1997 NODA, the proposed standard was 10 ppmv. However, based on comments to May 1997 NODA and the proposed rule, the standard is moved to 20 ppmv because:

- Similar to CKs, LWAKs use raw materials including slate, shale, and clay which contain varying levels of organics. Recent testing has shown that the raw materials can contain carbon in excess of 2%, which may lead to HC related to raw materials desorbed organics that are not representative of hazardous waste combustion. Thus, LWAKs have the same floor standard as cement kilns (i.e., 20 ppmv).
- The available HC data are from a relatively small time period during the CoC testing. However, the HC standard must be complied with on a continuous basis with a HC CEM. Thus, it is unlikely that the HC CoC test data samples can fully capture the potential

variability of HC emissions related to desorbed raw materials organics that potentially occur over a period of months or years.

- This is the standard that is currently enforced under current EPA RCRA BIF regulations.

Carbon Monoxide

Table 5-4 also summarizes CO (RA) and CO (MHRA) emissions from LWAKs. CO (MHRA) levels range from 3 to 1,300 ppmv.

The best performing sources control CO by maintaining good combustion conditions; however, as discussed for incinerators and cement kiln bypasses, MACT has not been quantitatively defined. The floor level is set at 100 ppmv. Evaluation of the CO (MHRA) data indicates that a floor level of 100 ppmv is being achieved by 12 of the 15 currently operating LWAKs. Of the three that are not meeting this level, ID No. 227 (with a level of 1,300 ppmv) is no longer burning hazardous wastes, and two others that have CO (MHRA) levels just above 100 ppmv meet the alternative MACT floor for HC. Additionally: (1) the floor level is identical to that currently enforced under RCRA BIF regulations; and (2) the floor is consistent with that for incinerators and cement kiln main/bypass standards, which are also based on GCP-D/O/M practices.

Note that, if complying with the CO standard on a continuous basis, a one-time demonstration of compliance with the HC standard is required.

5.3.2 New Sources Floor

The floor for new sources is the same as that for existing sources due to an identical definition of MACT -- CO of 100 ppmv and HC of 20 ppmv.

5.4 HC CEM PERFORMANCE LIMITATIONS

Proposed rule commenters note that laboratory scale studies have demonstrated various limitations of the Flame Ionization Detection (FID) CEMS analyzer for monitoring hydrocarbons, including: (1) interferences by CO, CO₂, NO_x, and HCl; (2) variations in different HC CEMS simultaneous readings on the same gas stream by over 50%; and (3) difficulties of measuring HC in moisture-saturated and/or high salt stack gases. Thus, basing the HC standard on FID data is not appropriate. Also, the use of a HC FID for compliance with a HC standard is not appropriate.

There are a variety of well known limitations of HC FID CEMS. Probably of most importance is that they have diminished (or no) response to halogenated and oxygenated hydrocarbons. For example, they do not respond to constituents such as formaldehyde and carbon tetrachloride. Additionally, some very limited laboratory work that the commenters reference has shown that differences in the flue gas constituents (including moisture, oxygen, CO, CO₂, and HCl levels) can bias the HC measurement by a couple ppmv in some cases for certain analyzers. However, the general accuracy of the HC FID CEMS was good, and they behaved as expected based on previous studies. Thus, HC MACT standards are set based on HC FID data because: (1) FID-based CEMS continue to be the most appropriate method for continuous monitoring of HC from combustion sources, and (2) the use of HC FID CEMS has been well demonstrated and established over the last few years in BIFs and incinerators to assure that proper combustion practices are maintained.

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
490C1	0								Rot Kiln
611C1	0					Nor			
904C2	0		5.0		C		100.000	100.000	Starved Air
209C7	0						99.999	99.996	Liq Inj
209C5	0						99.999	99.998	Liq Inj
904C3	0		9.3		C		100.000	100.000	Starved Air
904C4	0						100.000	99.999	Starved Air
210C2	0		2.8		H		100.000	100.000	Rot Kiln
606C1	0								
480C1	1		7.4		U		100.000	99.999	Rot Kiln
614C3	1		1.6		H	Nor			
480C2	1		7.5		U		100.000	99.999	Rot Kiln
904C1	1		7.8		C		100.000	100.000	Starved Air
337C2	1		3.3		H		100.000	100.000	Starved Air
348C2	1	5	0.9	4.4	H		100.000	100.000	Liq Inj
358C4	1						100.000	99.998	Liq Inj
209C8	1						99.999	99.989	Liq Inj
325C4	1		1.0		U		100.000	99.995	Rot Kiln
349C1	1						99.996	99.992	Rot Kiln
467C1	1					NLBHW	100.000	99.997	?
467C3	1					NLBHW	100.000	99.995	?
915C1	1		0.4		U		100.000	99.998	Rot Kiln
506C1	1		7.7		U				
350C5	1						100.000	99.995	Liq Inj
460C2	1		9.8		U		99.993	99.992	Liq Inj
350C3	1						100.000	100.000	Liq Inj
350C4	1						99.999	99.999	Liq Inj
603C7	1		4.6		U		100.000	100.000	Rot Kiln

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
703C2	1		0.4		U	NLBHW	100.000	99.998	Liq Inj
480C3	1		4.2		U		100.000	99.999	Rot Kiln
350C6	1						99.998	99.996	Liq Inj
601C1	1		1.1		H		100.000	100.000	
603B1	1		0.3		U		100.000	100.000	Rot Kiln
714C3	1						100.000	99.999	Liq Inj
704C3	1		1.7		U		99.999	99.996	Liq Inj
609C1	1		1.2		C		100.000	100.000	Rot Kiln/Liq Inj
603B3	1						100.000	100.000	Rot Kiln
350C7	1						100.000	100.000	Liq Inj
904C5	1						100.000	100.000	Starved Air
703C1	1		0.4		U	NLBHW	100.000	99.980	Liq Inj
601C3	1		0.2		H		100.000	100.000	
612C1	1		0.5		H		100.000	100.000	Fixed Hrth
467C2	1					NLBHW	100.000	99.996	?
350C8	1						100.000	100.000	Liq Inj
350C9	1						99.999	99.999	Liq Inj
216C5	1								Rot Kiln
489C1	1		8.9		U				Rot Kiln
604C1	2						100.000	99.999	
603C1	2		0.4		U		100.000	100.000	Rot Kiln
467C4	2					NLBHW	100.000	99.997	?
341C2	2						100.000	99.998	Fxd Hrth
455C1	2						99.998	99.995	Liq Inj
601C2	2		0.3		H		100.000	100.000	
348C3	2	3	0.6	1.8	H		100.000	100.000	Liq Inj
354C4	2								Rot Kiln
725C2	2		0.8		H		100.000	99.997	Liq Inj

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
338C1	2		1.3		C	Nor			Rot Kiln
338C2	2		2.2		C				Rot Kiln
337C1	2								Starved Air
488C2	2								Rot Kiln
488C3	2								Rot Kiln
807C1	2	9	2.4	2.2	C	NLBHW	100.000	99.999	Rot Kiln
325C6	3		0.5		U		100.000	99.995	Rot Kiln
784C1	3						99.999	99.999	?
358C1	3						100.000	99.985	Liq Inj
325C5	3		0.8		U		100.000	99.995	Rot Kiln
603C5	3		0.8		U		100.000	100.000	Rot Kiln
354C2	3						100.000	99.998	Rot Kiln
356C1	3					NLBHW			Liq Inj
354C1	3						100.000	99.994	Rot Kiln
325C7	3		1.0		U		100.000	100.000	Rot Kiln
483C3	3						99.999	99.996	Liq Inj
705C2	4						100.000	99.994	Rot Kiln
708C1	4						100.000	99.997	Liq Inj
914C1	4					NLBHW			?
807C3	4	16	1.8	2.1	C	NLBHW	100.000	100.000	Rot Kiln
349C3	4								Rot Kiln
212C1	4		4.2		H		100.000	99.999	Rot Kiln
211C1	4		2.8		H		100.000	99.997	Rot Kiln
327C2	4		4.6		C		100.000	100.000	Rot Kiln
333C2	5						100.000	99.040	Rot Kiln
458C1	5						99.998	99.996	Liq Inj
456C1	5						99.995	99.342	Liq Inj
483C1	5						99.998	99.993	Liq Inj

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
708C2	5						100.000	99.997	Liq Inj
704C1	5						100.000	99.998	Liq Inj
784C2	5						99.999	99.999	?
350C2	5						100.000	100.000	Liq Inj
906C4	5		2.0		H		100.000	99.999	Liq Inj
341C1	5						100.000	99.997	Fxd Hrth
906C3	5		2.6		H	Nor	100.000	99.999	Liq Inj
705C1	5						100.000	99.998	Rot Kiln
906C2	5		1.3		H		100.000	99.999	Liq Inj
709C1	5	8	1.5		U	NLBHW	100.000	99.999	Liq Inj
483C2	5						99.999	99.996	Liq Inj
331C2	6		0.4		H		100.000	99.999	Rot Kiln
906C1	6		1.4		H	Nor	100.000	99.999	Liq Inj
603C8	6		1.2		U		100.000	100.000	Rot Kiln
725C1	6		0.5		H		100.000	99.761	Liq Inj
354C3	6						100.000	99.998	Rot Kiln
603C4	6		0.4		U		100.000	100.000	Rot Kiln
325C3	7	11					100.000	100.000	Rot Kiln
347B3	7	20					99.999	99.997	Rot Kiln
460C3	7		13.5		U		99.995	99.993	Liq Inj
214C1	7		1.1		H		100.000	99.995	Rot Kiln
603C9	7		1.3		U		100.000	100.000	Rot Kiln
824C1	7						99.994	99.992	Liq Inj
603C3	7		0.1		U		100.000	100.000	Rot Kiln
351C3	8	13							Rot Kiln
348C1	8						100.000	99.430	Liq Inj
331C3	8		0.7		H		100.000	100.000	Rot Kiln
333C1	8						100.000	98.940	Rot Kiln

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
711C1	8						100.000	99.997	Lq In/Rt Kln
477C3	8		1.0		H		99.999	99.998	Liq Inj
351C2	8	13					100.000	100.000	Rot Kiln
327C1	9		4.1		C		100.000	100.000	Rot Kiln
714C5	9						100.000	99.998	Liq Inj
488C1	9								Rot Kiln
221C1	9		3.8		C		100.000	100.000	Rot Kiln
614C1	9		0.9		H	Nor			
915C4	10								Rot Kiln
713C1	10					NLBHW	100.000	99.989	Rot Kiln
334C1	10		2.0		H		100.000	99.420	Rot Kiln
327C3	10		6.9		C		100.000	100.000	Rot Kiln
353C1	10						100.000	99.630	Rot Kiln
329C1	10		2.5		H	NLBHW	100.000	99.999	Rot Kiln
209C4	10						99.999	99.995	Liq Inj
216C6	10								Rot Kiln
222C3	11		0.6		U		100.000	99.997	Rot Kiln
331C6	11						100.000	100.000	Rot Kiln
357C1	11						99.999	99.997	Rot Kiln
455C3	11		1.1		U		100.000	99.996	Liq Inj
906C5	12						100.000	100.000	Liq Inj
807C2	12		5.3	5.7	C	NLBHW	100.000	100.000	Rot Kiln
603C6	12		0.3		U		100.000	100.000	Rot Kiln
340C2	12		1.5		C		99.999	99.998	Fluid Bed
605C1	13					Nor			
808C2	13						100.000	100.000	Rot Kiln
400C1	13		3.0		H	NLBHW			LWAK
455C4	13		0.9		U		100.000	99.999	Liq Inj

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
455C2	14		5.2		U		100.000	99.997	Liq Inj
344C1	14		2.3		U		100.000	100.000	Liq Inj
710C1	15		2.6	4.8	H	NLBHW	100.000	99.999	Lq In/Rt Kln
221C4	15		3.0		C		100.000	100.000	Rot Kiln
708C3	15						100.000	99.997	Liq Inj
711C3	15						100.000	99.998	Lq In/Rt Kln
347B4	15	63					100.000	99.999	Rot Kiln
331C7	15						100.000	100.000	Rot Kiln
710C3	16		5.7	5.7	H	NLBHW	100.000	99.999	Lq In/Rt Kln
810C1	16								Liq Inj
353C2	16						100.000	99.880	Rot Kiln
710C2	17		1.0	2.1	H	NLBHW	100.000	99.999	Lq In/Rt Kln
349C2	17						100.000	100.000	Rot Kiln
726C2	17		1.2		U		100.000	100.000	Liq Inj
221C2	17		4.2		C		100.000	100.000	Rot Kiln
221C5	18		3.3		C		100.000	100.000	Rot Kiln
347C9	18	28							Rot Kiln
714C2	18						100.000	99.998	Liq Inj
711C2	18						100.000	99.995	Lq In/Rt Kln
614C2	19		1.0		H	Nor			
454C1	19						99.999	99.995	Liq Inj
214C3	19		1.6		C		100.000	99.998	Rot Kiln
221C3	20		3.3		C		100.000	100.000	Rot Kiln
331C5	21						100.000	100.000	Rot Kiln
344C2	21						100.000	100.000	Liq Inj
726C1	23		22.4		U	Bad HC data (contamination in line)	100.000	100.000	Liq Inj
214C2	24		1.1		C		100.000	99.999	Rot Kiln
810C2	25								Liq Inj

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
324C3	26						99.994	99.992	Batch
484C3	27						100.000	99.999	Liq Inj
353C3	27								Rot Kiln
346C1	28					RCRA trial burn M55 VS Rockets	100.000	99.999	Rot Kiln
324C4	29						99.994	99.992	Batch
331C8	30						100.000	100.000	Rot Kiln
503C5	31		19.1		U	Inst. max for HC, Rotary kiln w/ AB, propellant waste	99.999	99.998	Rot Kiln
706C1	32		5.4		U		100.000	99.999	Liq Inj
477C1	34		2.7		U		100.000	99.980	Liq Inj
222C1	34		0.3		U		100.000	99.999	Rot Kiln
324C1	35						99.995	99.994	Batch
905C1	35								Liq Inj
222C6	36		0.2		U		100.000	99.994	Rot Kiln
503C4	39		17.2		U	Inst. max for HC, Rotary kiln w/ AB, propellant waste			Rot Kiln
902C1	41		5.4		U	NLBHW	100.000	99.999	Sub. Qnch
324C2	43						99.989	99.921	Batch
706C2	43		4.6		U		100.000	99.999	Liq Inj
347B2	44	86					100.000	99.985	Rot Kiln
216C7	44								Rot Kiln
706C3	44		5.4		U		100.000	99.999	Liq Inj
714C1	46						100.000	99.998	Liq Inj
347B1	49	114							Rot Kiln
340C1	50		2.2		C		100.000	99.996	Fluid Bed
351C4	52						100.000	100.000	Rot Kiln
351C1	53						99.999	99.998	Rot Kiln
503C3	62		17.8		U	Inst. max for HC, Rotary kiln w/ AB, propellant waste			Rot Kiln
331C4	64						100.000	100.000	Rot Kiln
222C2	64		0.4		U		100.000	99.967	Rot Kiln

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
806C1	68		10.6		H		100.000	99.999	Fluid Bed
710C4	70		1.5		H	NLBHW	100.000	99.999	Lq In/Rt Kln
710C5	73					NLBHW			Lq In/Rt Kln
331C9	73						100.000	100.000	Rot Kiln
453C1	77						100.000	99.995	Liq Inj
484C2	79								Liq Inj
359C6	100								Rot Kiln
915C2	100		0.3		U	915C1/4	100.000	100.000	Rot Kiln
915C3	109		1.2		U	915C1/4	100.000	100.000	Rot Kiln
459C1	109					Liquid injection quick quench, old data	100.000	100.000	Liq Inj
503C6	114		18.6		U	Inst. max for HC, Rotary kiln w/ AB, propellant waste	99.999	99.992	Rot Kiln
359C4	120					Rotary kiln w/ AB			Rot Kiln
359C5	121					Rotary kiln w/ AB			Rot Kiln
350C1	140					350C2/3/4/5/6/7/8/9, single high outlier run	100.000	100.000	Liq Inj
805C3	149		1.6		U	Nor, Quick quench, aqueous waste			SQ/Fxd Hrth
334C2	166		2.0		H	334C1, rotary kiln w/ AB, DREs < 99.99	100.000	99.620	Rot Kiln
477C5	174		0.8		H	Nor, 477C1/3, quick quench, aqueous waste			Liq Inj
808C1	202					High single outlier run, quick quench, aqueous waste	100.000	99.992	Rot Kiln
457C1	215					Old data, NLBHW			Liq Inj
209C6	226					209C4/5/7/8, high single outlier run	99.999	99.999	Liq Inj
477C4	261		9.8		H	477C1/2, quick quench aqueous waste	99.998	99.995	Liq Inj
460C1	275		4.4		U	460C2/3, old data	99.998	99.992	Liq Inj
727C1	296		24.3		U	Rot kiln, no AB, explosives wastes	100.000	100.000	Rot Kiln
477C2	297		5.2		U	477C1/3, quick quench, aqueous waste	100.000	100.000	Liq Inj
325C1	308	382				325C3/4/5/6/7/8, high single outlier run	100.000	100.000	Rot Kiln
806C2	320		35.8		H	806C1, fluidized bed w/ high excess air	100.000	99.999	Fluid Bed
805C2	329					Quick quench, aqueous waste	100.000	99.999	SQ/Fxd Hrth
805C1	343		7.1		U	Quick quench, aqueous waste, DREs < 99.99	100.000	99.935	SQ/Fxd Hrth

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
478C1	364		4.3		H	Nor, Quick quench, aqueous waste			Liq Inj
484C1	434						100.000	99.996	Liq Inj
325C2	438	553				325C3/4/5/6/7/8, high single outlier run	100.000	100.000	Rot Kiln
332C1	557					Mult hearth, no AB, quick quench, NLBHW	99.998	99.992	Fxd Hrth
468C1	581					Liq inj, old data	100.000	99.997	Liq Inj
809C1	1249		4.4		U	Rot kiln, no AB , aqueous waste			Rot Kiln
809C2	1266		4.3		U	Rot kiln, no AB , aqueous waste			Rot Kiln
209C3	1498					209C4/5/7/8, liq inj, non-aqueous waste	99.999	99.989	Liq Inj
707A5	1708					Quick quench, aqueous waste	100.000	100.000	Liq Inj
707A4	3145					Quick quench, aqueous waste	100.000	100.000	Liq Inj
727C2	3717		299.3		U	Rot kiln, no AB, explosives wastes, DREs < 99.99	99.930	99.400	Rot Kiln
707A2	3725					Quick quench, aqueous waste			Liq Inj
707C4	4190					Quick quench, aqueous waste, DREs < 99.99	100.000	99.974	Liq Inj
463C1	4989					Liq inj, old data, DREs < 99.99	100.000	89.000	Liq Inj
707C3	5786					Quick quench, aqueous waste, DREs < 99.99	100.000	99.962	Liq Inj
707A6	5935					Quick quench, aqueous waste, DREs < 99.99	100.000	99.969	Liq Inj
707C2	6711					Quick quench, aqueous waste	100.000	99.999	Liq Inj
707A3	6974					Quick quench, aqueous waste	100.000	100.000	Liq Inj
707C8	9586					Quick quench, aqueous waste			Liq Inj
707A1	10040					Quick quench, aqueous waste			Liq Inj
707C7	10324					Quick quench, aqueous waste			Liq Inj
707C1	10385					Quick quench, aqueous waste			Liq Inj
707C9	10460					Quick quench, aqueous waste	100.000	99.997	Liq Inj
325C8			0.2		H	Nor			Rot Kiln
603C2			0.3		U		100.000	100.000	Rot Kiln
348C4			0.7	2.7	H		100.000	100.000	Liq Inj
603B2			1.0		U		100.000	100.000	Rot Kiln
339C1			1.3		H	NLBHW	100.000	99.911	Fxd Hrth

TABLE 5-1. INCINERATOR CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				HC FID Meth	Summary Comments	POHC DRE (%)		Inc Type
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)			Max	Min	
701C3			1.6		U				Rot Kiln
210C1			5.3		H		100.000	99.996	Rot Kiln
470C1			5.7		U		100.000	100.000	Fxd Hrth
344C3			6.0		U		100.000	100.000	Liq Inj
471C1			11.0		U		100.000	100.000	Fxd Hrth
494C1		8							
493C1		43							

TABLE 5-2. MORE CO/HC DATA FROM HAZARDOUS WASTE INCINERATORS

Incinerator	Inc. Type	Run No.	CO (ppmv @ 7% O ₂)			HC (ppmv @ 7% O ₂)	
			RA	MHRA	Range	RA	Range
Plant B	?	1	23	27	14 - 37	< 1	< 1
		2	< 5	< 5	< 5	< 1	< 1
		3	10	14	< 5 - 33	< 1	< 1 - 2.9
American Cyanamid	Liq. Inj.	1	9	11	2 - 65	< 1	< 1 - 1.6
		2	96	120	14 - 570	< 1	< 1
		4	28		11 - 45	< 1	< 1
		5	38	41	13 - 400	1.0	< 1 - 1.1
DuPont	Rot. Kiln and Liq. Inj.	1	530	650	25 - 2000	75.9	45 - 140
		2	330	510	25 - 2100	47.6	36 - 86
		3	680	910	40 - 2500	58.1	39 - 87
Mitchell	Liq. Inj.	1	< 5	< 5	< 5 - 7	< 1	< 1
		2	< 5	< 5	< 5 - 7	< 1	< 1
		3	19	40	< 5 - 700	0.6	0.2 - 1.8
		4	< 5	< 5	< 5 - 22		
Ross	Rot. Kiln and AB	1	8	9	< 5 - 27	< 1	< 1
		2	14	17	7 - 25	0.9	0.8 - 2.3
		3	7	9	< 5 - 15	1.0	< 1 - 2.3
TWI	Contr. Air	1	7	13	< 5 - 120	2.5	2.0 - 2.9
		2	< 5	< 5	< 5 - 23	1.9	1.7 - 2.1
		3	< 5	< 5	< 5	1.7	1.3 - 2.2
		4	< 5	< 5	< 5 - 6	0.8	0.3 - 2.1
Upjohn	Liq. Inj.	1	11	13	9 - 14	8.9	7.1 - 12
		2	12	12	10 - 14	6.0	4.5 - 9
		3	12	12	11 - 13	3.9	3.1 - 6
		4	10	10	9 - 11		
Zapata	Contr. Air	2	36	68	< 5 - 620	1.9	< 1 - 41
		3	7	8	5 - 10	< 1	< 1
		4	15	22	4 - 33	< 1	< 1 - 2.9

Notes:

RA -- Run Average; MHRA -- Maximum hourly rolling average; HC data taken with heated FID and reported as propane

Source: Trenholm, A., P. Gorman, and G. Jungclaus, "Performance Evaluation of Full-Scale Hazardous Waste Incinerators, Vol. 2 - Incinerator Performance Results," EPA-600/2-84-181b, PB 85-129518, November 1984.

TABLE 5-3. CEMENT KILN MAIN STACK CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				Summary Comments	Cond Date
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)		
Part 1. Kilns burning hazardous waste						
319C5	184		0.0		B, Nor	12/1/90
202C2	1007	1565	1.5	2.6		10/1/92
323B4	606	962	2.9	3.3		11/1/95
323B5	166	227	3.1	3.4		11/1/95
323B3	170	301	3.3	3.4		11/1/95
206C4	115		4.0		B	8/1/92
202C1	255	376	4.0	4.8		10/1/92
320C4	256	469	5.0	7.7		8/1/95
323C9	49		5.5			6/1/96
228C2	236	356	5.5	8.1	B	5/1/92
323B1	36		5.8			6/1/96
202C8	867		5.9			12/1/96
401C5	432	612	6.3	6.9		3/1/94
322C1	364	594	6.5	7.4		8/1/92
323B2	150		6.5			6/1/96
404C9	258	383	6.6	8.6		5/19/95
401C3	391	638	6.7	7.6		3/1/94
228C3	316	701	7.2	12.3		5/1/92
323C1	327	692	8.1	10.5		8/1/92
323C8	50	52	8.2	9.3		9/1/94
404B1	262	425	8.3	10.9		5/19/95
320C3	547	912	8.4	13.7		8/1/95
401C4	283	491	8.6	12.4		3/1/94
404C4	610	760	8.7	10.1		1/17/95
322C3	66	73	9.6	10.2		9/1/94
404C3	281	414	9.9	14.5		1/17/95
403C1	248	487	9.9	15.3		10/1/92
404C1	459	660	10.5	12.7		11/1/92
322C9	733	1067	10.7	11.3		11/1/95
322C8	219	297	11.0	12.0		11/1/95
302C3	93	98	11.3	15.0		8/1/95
228C4	248	380	12.0	15.7		7/1/93
302C2	191	416	13.7	17.3		9/1/94
404C2	401	704	13.8	19.8		11/1/92
302C4	187	263	14.0	16.0		8/1/95
206C3	163		14.1			8/1/92
403C2	413	741	14.3	19.5		10/1/92
206C1	154		14.4			8/1/92
335C1	159		14.5			6/1/92
205C6	190	298	14.7	16.4		9/15/95
305C5	203	195	15.4	15.0		6/24/94
206C2	153		15.8			8/1/92
300C1	379	623	15.8	19.0		8/20/92
203C6	315	410	16.0	19.0		8/16/96
205C5	154		16.1	17.0		9/15/95
228C1	515	773	16.3	22.5		5/1/92
206C6	196	280	16.8	18.8		9/15/95

TABLE 5-3. CEMENT KILN MAIN STACK CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				Summary Comments	Cond Date
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)		
491C1	739		16.9			8/18/95
203C5	240		17.0	19.0		8/16/96
300C2	98	170	17.1	19.3		8/20/92
206C5	154		17.5	18.2		9/15/95
205C3	167		18.3		B	8/1/92
203C1	278	300	18.5	19.1		8/19/93
205C4	164		19.3			8/1/92
402C2	714	1156	20.0	26.7		3/24/92
491C2	1466		20.8			8/18/95
305C3	3995		22.7			8/20/92
402C1	631	1444	23.8	33.5		3/27/92
205C2	174		25.8			8/1/92
205C1	132		26.4			8/1/92
303C2	2040		35.7		Short	1/1/93
303C8	3478		36.2		Short	12/1/95
401C2	394	625	36.5	40.7		4/7/92
303C9	2819		46.2		Nor, Short	12/1/95
401C1	618	1486	48.3	61.8		4/9/92
402C6	256	562	50.4	54.3		7/1/92
303C3	2700		59.7		Short	1/1/93
319C2	343		60.1			5/5/92
319C4	349		61.2			5/5/92
303C7	5505		61.4		Short	12/1/95
320C1	1512	2072	69.3	100.0		8/1/92
319C1	296		76.0			5/5/92
303C1	1234		87.3		B, Nor, Short	1/1/93
200C3	363		87.8		Nor	7/9/91
204C5	259		158.7		Nor	7/8/94
204C7	257		160.1			7/18/94
204C6	262		164.4			7/18/94
204C8	271		168.7			7/18/94
318C2				5.1		5/24/93
318C1		248		6.1		5/24/93
318C3				7.6		5/24/93
200C6		301		11.6		8/1/95
200C5		330		13.4		8/1/95
200C4		685		15.4		8/1/95
403C3		706		15.5		11/1/94
403C4		465		16.3		11/1/94
207C2	25	31				1/1/93
319B3	26					8/23/93
207C1	26	34				1/1/93
319B6	31				B, Nor	8/23/93
319B4	32					8/20/93
319B5	33					8/23/93
228C6	42					10/1/88
208C1	47	50				1/1/93
208C2	50	54				1/1/93

TABLE 5-3. CEMENT KILN MAIN STACK CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				Summary Comments	Cond Date
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)		
300C7	86					5/1/87
300C6	93				B, Nor	5/1/87
228C7	96					10/1/88
319C7	220				B, Nor	12/1/90
319C6	240					12/1/90

Part 2. Kilns no longer burning hazardous waste

301C2	605		10.7		NLBHW, Short	5/1/93
309C1	101	132	10.9	13.5	NLBHW	10/1/92
406C6			11.1		NLBHW, B, Nor, Short	11/1/90
301C1	1259		11.1		NLBHW, Short	5/1/93
301C4	400		11.3		NLBHW, Nor, Short	6/1/93
406C7			11.5		NLBHW, Short	11/1/90
406C8			12.4		NLBHW, Short	4/25/88
309C7	230	240	13.4	14.8	NLBHW	7/1/96
405C1	1007	1191	13.5	21.5	NLBHW, Short	8/1/92
309C2	136	145	14.9	16.8	NLBHW	10/1/92
405C2	700	1077	16.3	21.0	NLBHW, Short	8/1/92
301C3	119		16.7		NLBHW, Short	5/1/93
406C5			18.6		NLBHW, Short	11/1/90
317C3	349		53.7		NLBHW, B, Nor, Short	1/22/93
317C1	317		54.2		NLBHW, Short	1/22/93
317C2	339		54.8		NLBHW, Short	1/22/93
315C5	260		104.5		NLBHW, Short	4/16/91
315C6	230		111.5		NLBHW, B, Nor, Short	4/16/91
315C4	297		139.0		NLBHW, Short	4/16/91
306C1	14	41			NLBHW	5/1/93
309C6	280	300			NLBHW	7/1/96

TABLE 5-4. CEMENT KILN BYPASS STACK CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				Summary Comments	Cond Date
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)		
303C3		23		0.0		1/1/93
321C1	23	39				8/1/92
321C5	27	47				8/1/95
321C6	44	56				8/1/95
204B2	52	58			Long mid-kiln bypass	9/13/96
204B1	58	70			Long mid-kiln bypass	9/13/96
204C9	50	75			Long mid-kiln bypass	9/13/96
303C2		84		0.0		1/1/93
204B3	50	98			Long mid-kiln bypass	9/13/96
402C4	602		7.0		Long mid-kiln bypass	4/4/94
402C3	720		15.0		Long mid-kiln bypass	4/4/94
406C7			0.4		NLBHW	11/1/90
406C5			0.8		NLBHW	11/1/90
406C6			1.1		NLBHW	11/1/90
301C4	57		1.6		NLBHW	6/1/93
315C2	2	6	1.7	2.0	NLBHW	7/15/92
315C3	36		2.0		NLBHW	7/15/92
315C1	37	50	2.1	2.6	NLBHW	7/15/92
406C4	282	483	2.2	4.6	NLBHW	8/1/95
315C4	53		2.7		NLBHW	4/16/91
406C2	286	568	3.0	4.7	NLBHW	8/1/92
315C6	3		3.4		NLBHW	4/16/91
406C3	416	740	3.4	4.7	NLBHW	8/1/95
316C2	131	283	4.3	5.0	NLBHW	3/25/92
316C1	133	293	5.8	7.0	NLBHW	3/25/92
406C1	230	522	6.4	10.7	NLBHW	8/1/92
406B4	219	545	10.2	15.1	NLBHW	8/1/92
301C2	4		14.0		NLBHW	5/1/93
301C1	265		14.8		NLBHW	5/1/93
315C5	47		19.0		NLBHW	4/16/91
301C3	0		26.0		NLBHW	5/1/93

TABLE 5-5. LWAK CO/HC

EPA Cond ID	Cond Avg Emiss (ppmv)				Cond Date	Summary Comments
	CO (RA)	CO (MHRA)	HC (RA)	HC (MHRA)		
314C3	2	2			1/1/96	
314C1	3	4	3.0	4.9	6/2/92	Liq. waste feed, 1800°F temp.
224C2	7	7			8/1/96	
224C1	7	8			7/8/93	
476C1	8	10			2/1/93	Nor
223C1	9	9			6/29/92	
313C1	15	27	2.9	4.6	6/14/92	Liq. waste feed, 1800°F temp.
225C2	16	27			8/1/96	
226C1	16	22			3/27/93	
608C1	17		4.7		3/1/96	
226C2	22	29			8/26/97	
479C2	30				8/1/90	B, pre-BIF
225C1	34	57			7/20/93	
307C3	41				12/1/92	Min. comb. temp., max. chlorine and waste feed
307C1	46				12/1/92	Min. comb. temp., min. chlorine feed
307C2	47				12/1/92	Max. comb. temp., chlorine feed
479C1	47				8/1/90	Nor, 100% LGF
307C4	49				12/1/92	Max. comb. temp., max. chlorine and waste feed
310C2	57	64			8/16/95	
336C2	59	67	4.6	4.9	3/24/94	
311C1	60	71	4.7	5.3	6/18/92	Liq. waste feed, 1800°F temp
336C1	60	71	4.7	5.3	6/16/92	
310C1	88	116	3.2	3.9	7/8/92	Liq. waste feed, 1800°F temp
312C1	88	116	3.2	3.9	6/16/92	Liq. waste feed, 1800°F temp
227C1	786	1289	9.4	12.8	1/1/94	NLBHW, max. waste and raw mat. feed
474C1		58		3.2	9/1/94	
475C1		136		5.8	6/23/93	

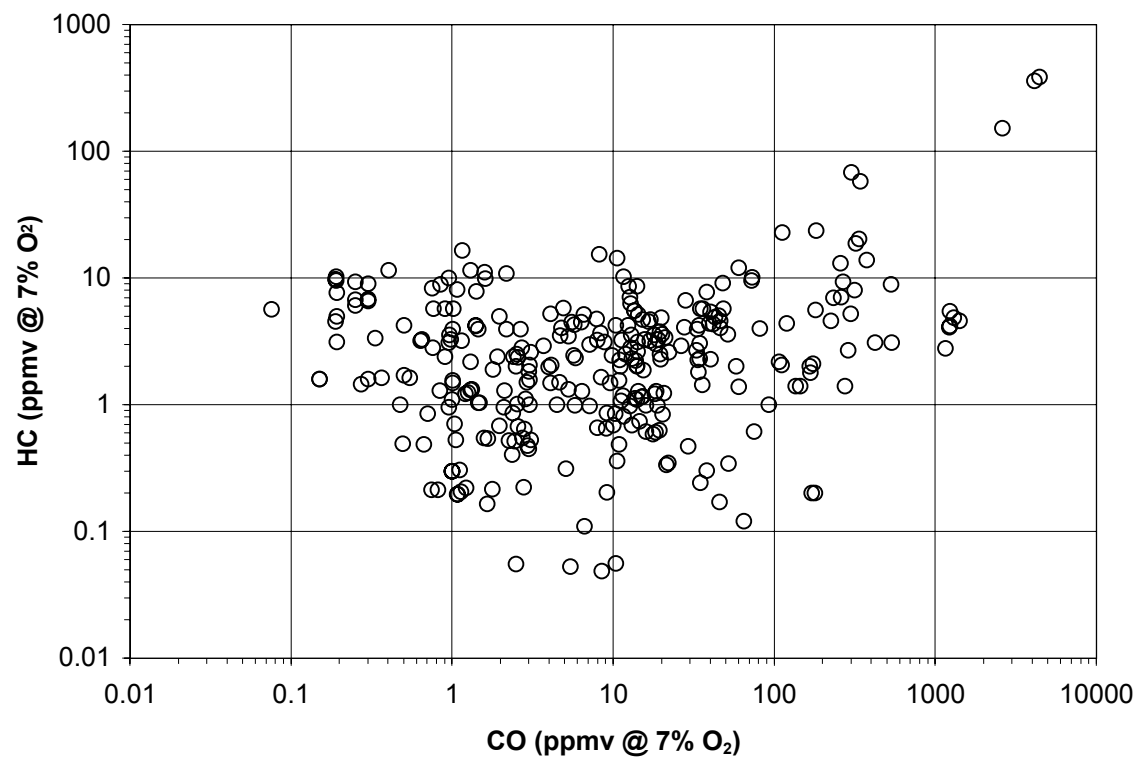


Figure 5-1. Relationship between CO and HC for hazardous waste incinerators (trial burn simultaneous run-average measurements).

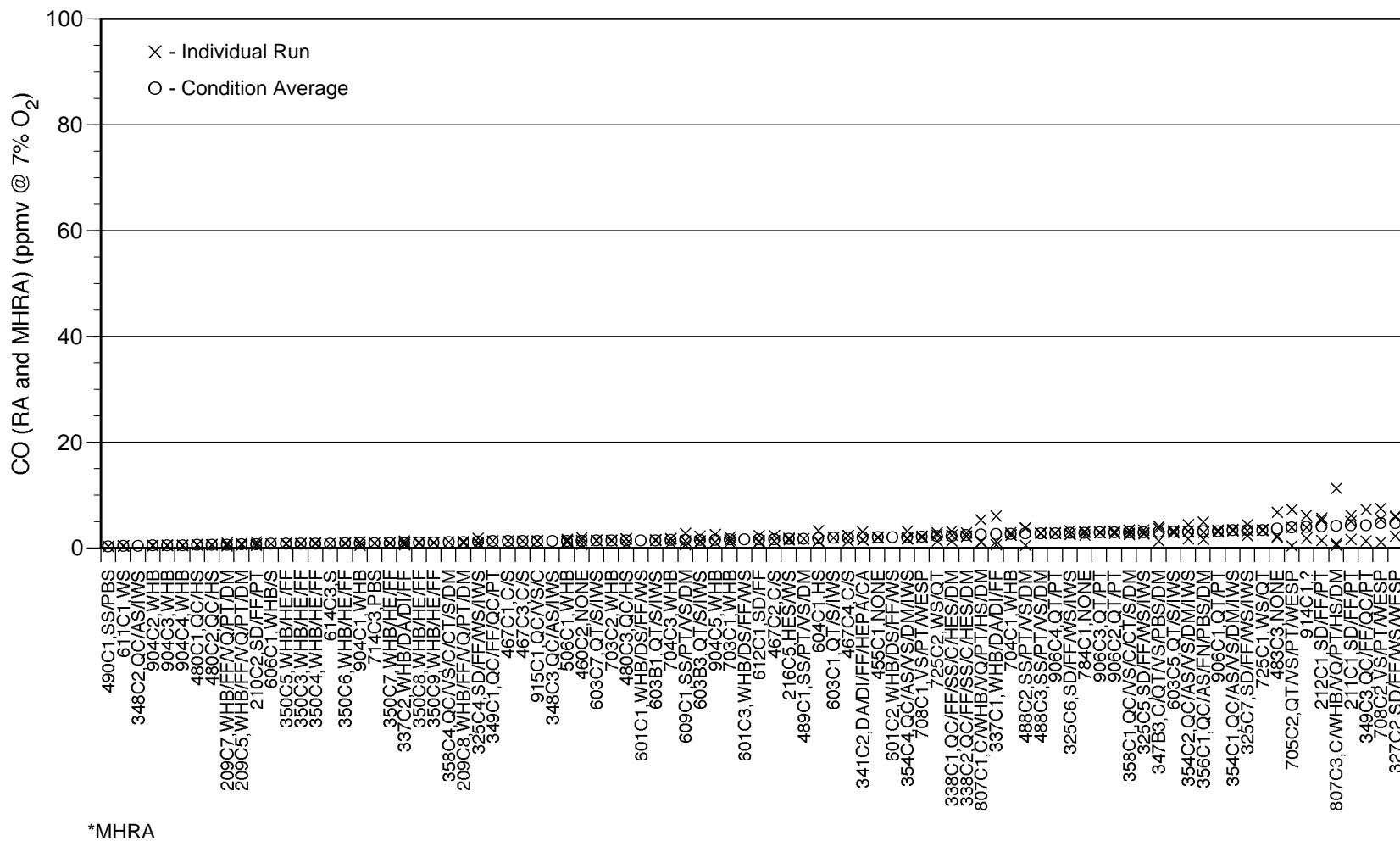


Figure 5-2a. Incinerator carbon monoxide emissions (1 of 3).

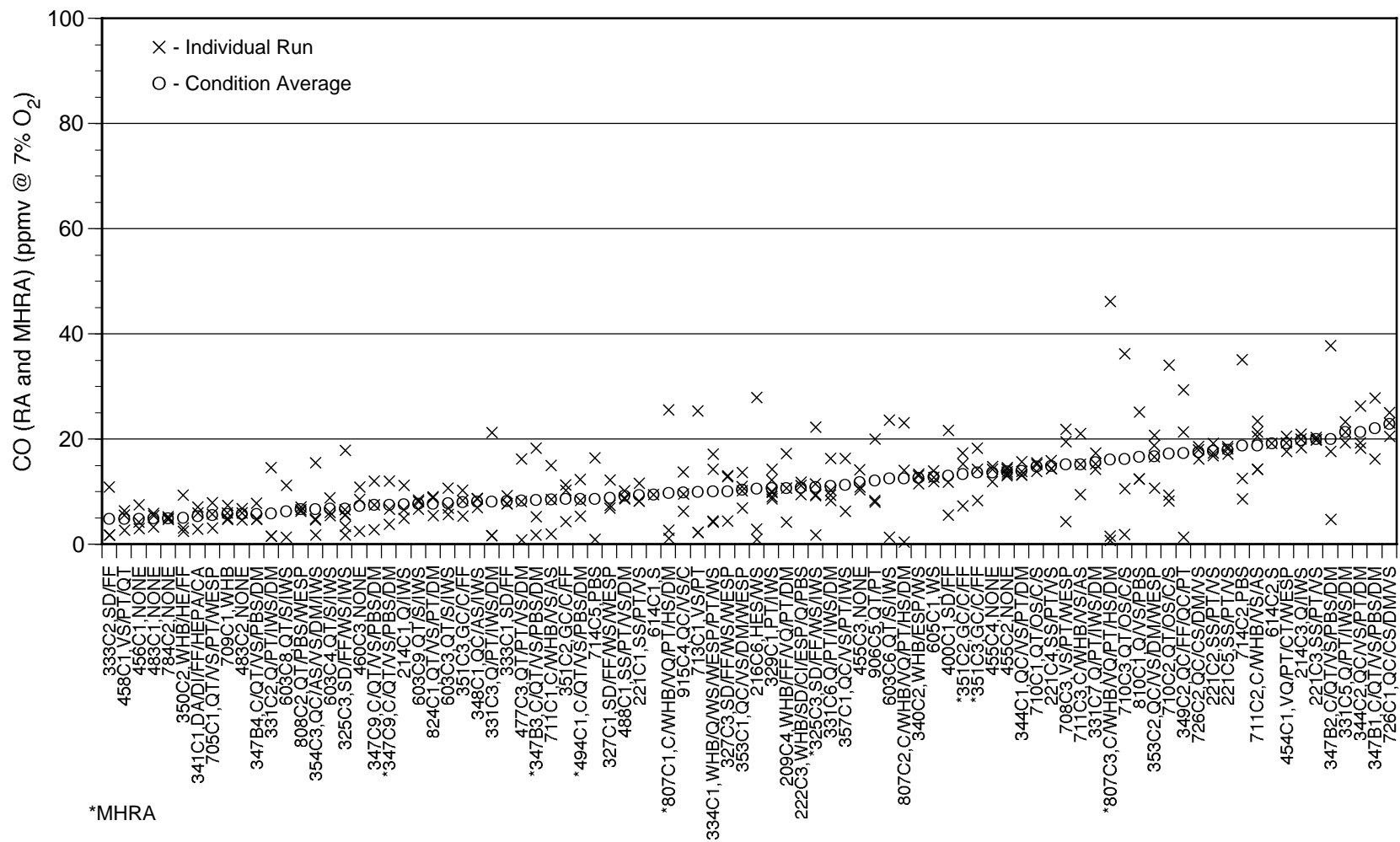
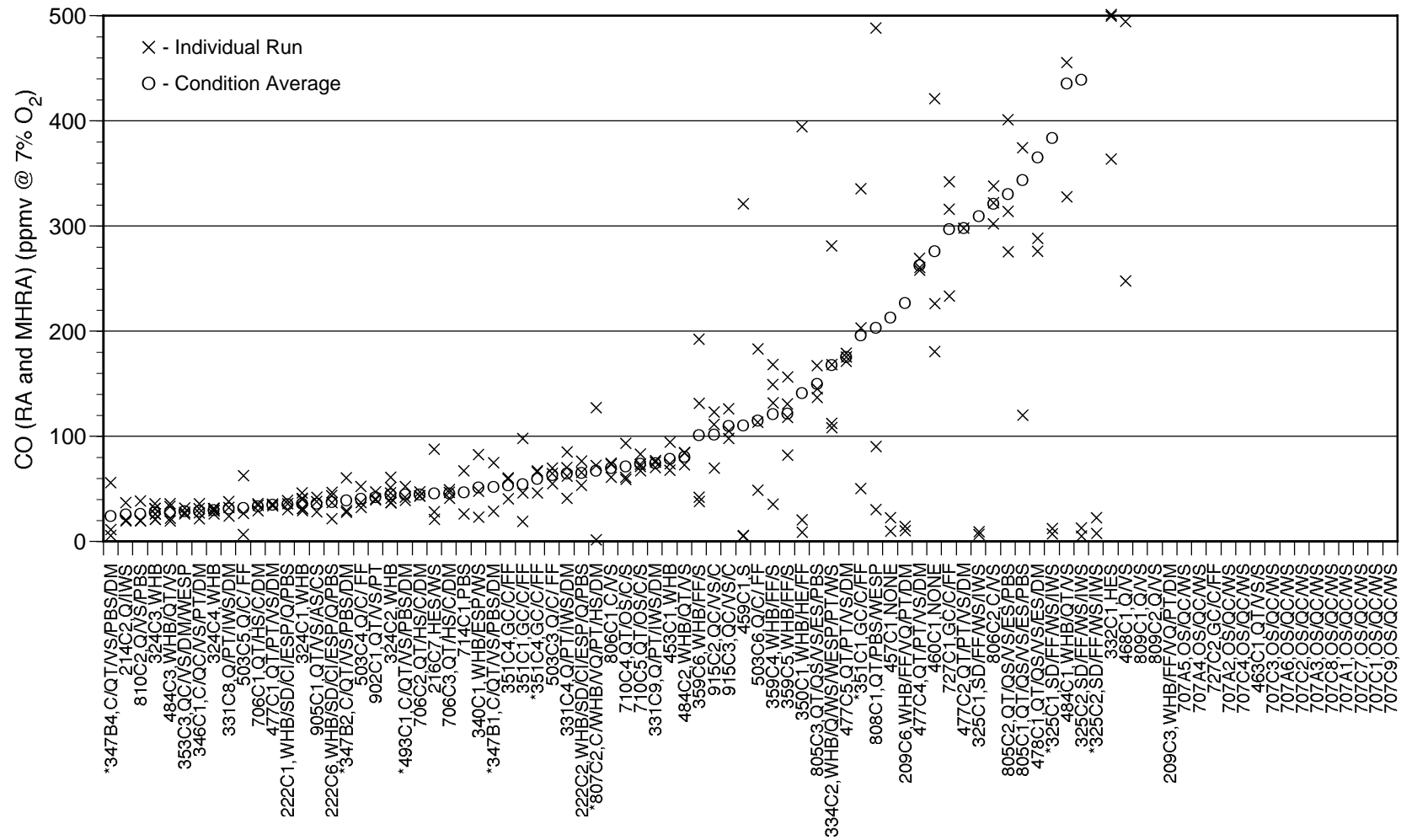


Figure 5-2b. Incinerator carbon monoxide emissions (2 of 3).



*MHRA

Figure 5-2c. Incinerator carbon monoxide emissions (3 of 3).

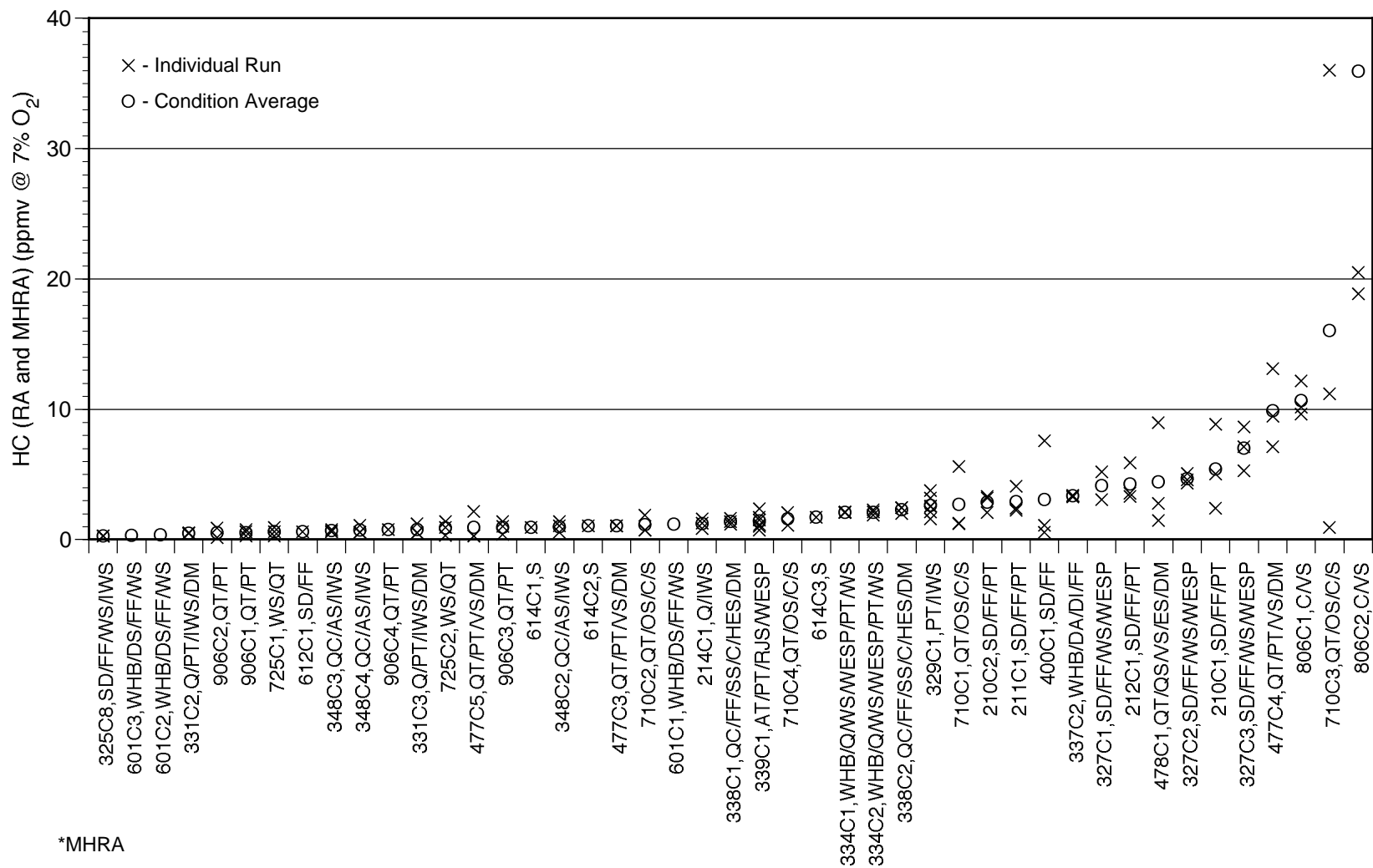


Figure 5-3. Incinerator hydrocarbon emissions (using hot FIDs).

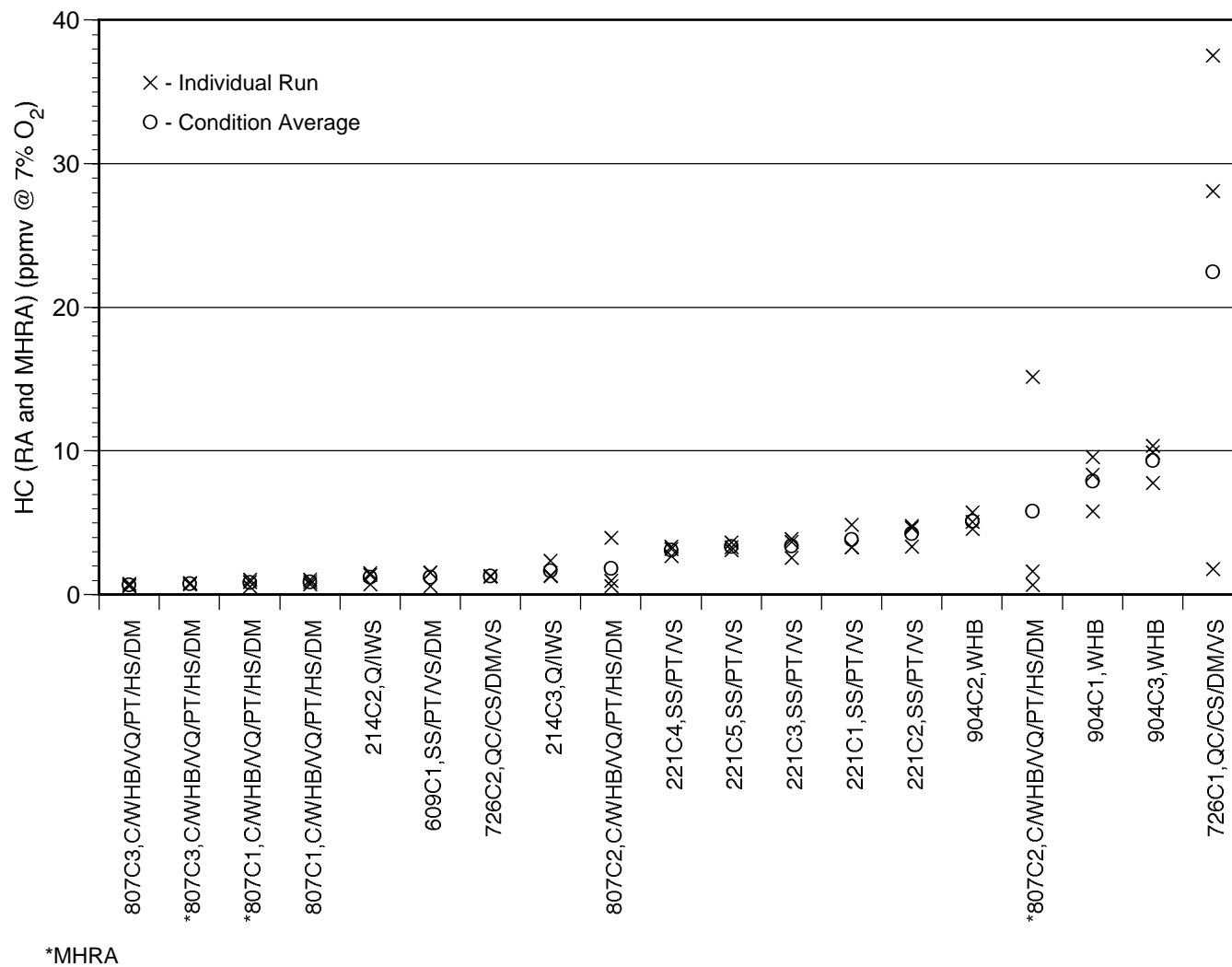


Figure 5-4. Incinerator hydrocarbon emissions (using cold FIDs).

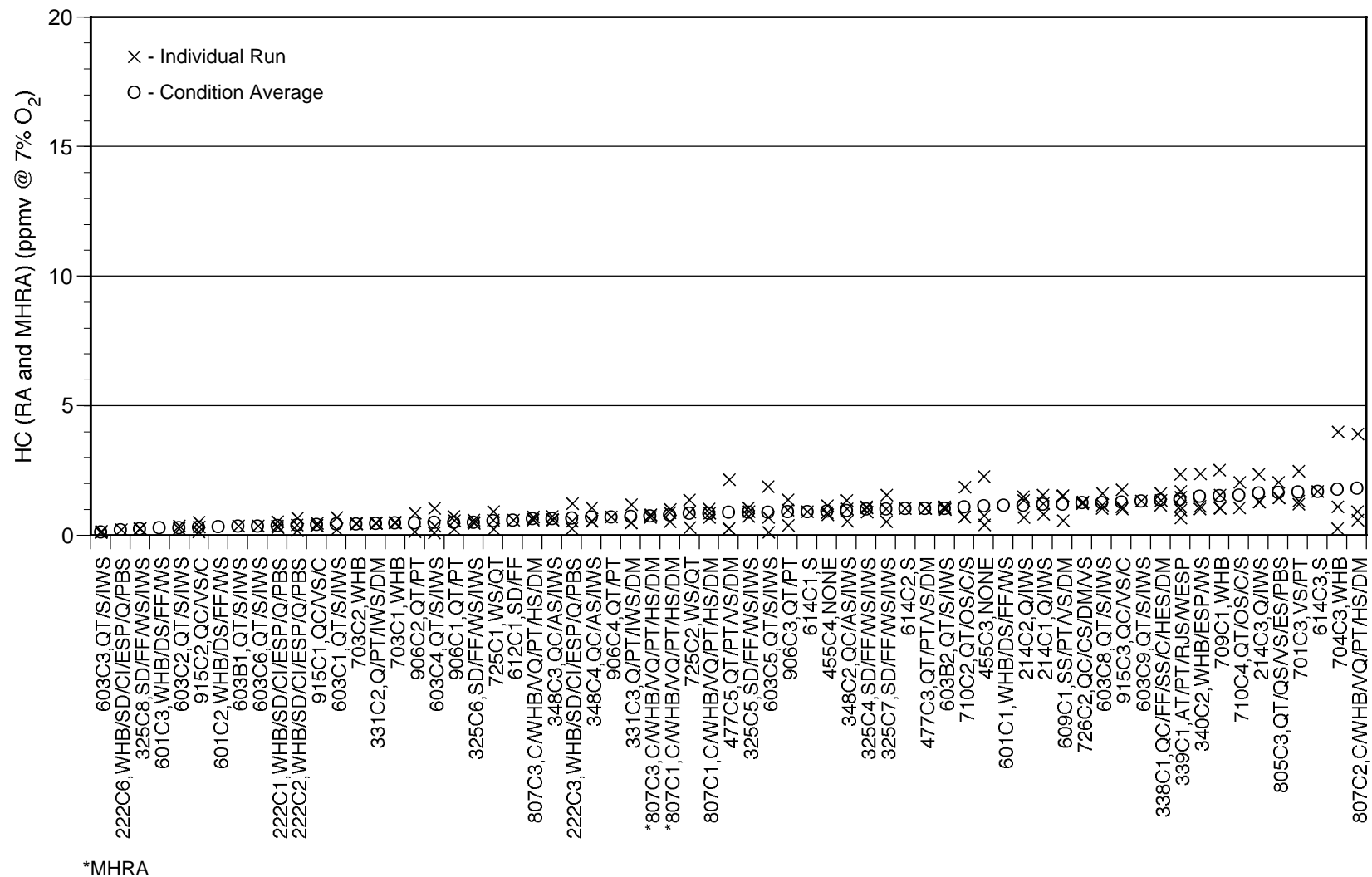
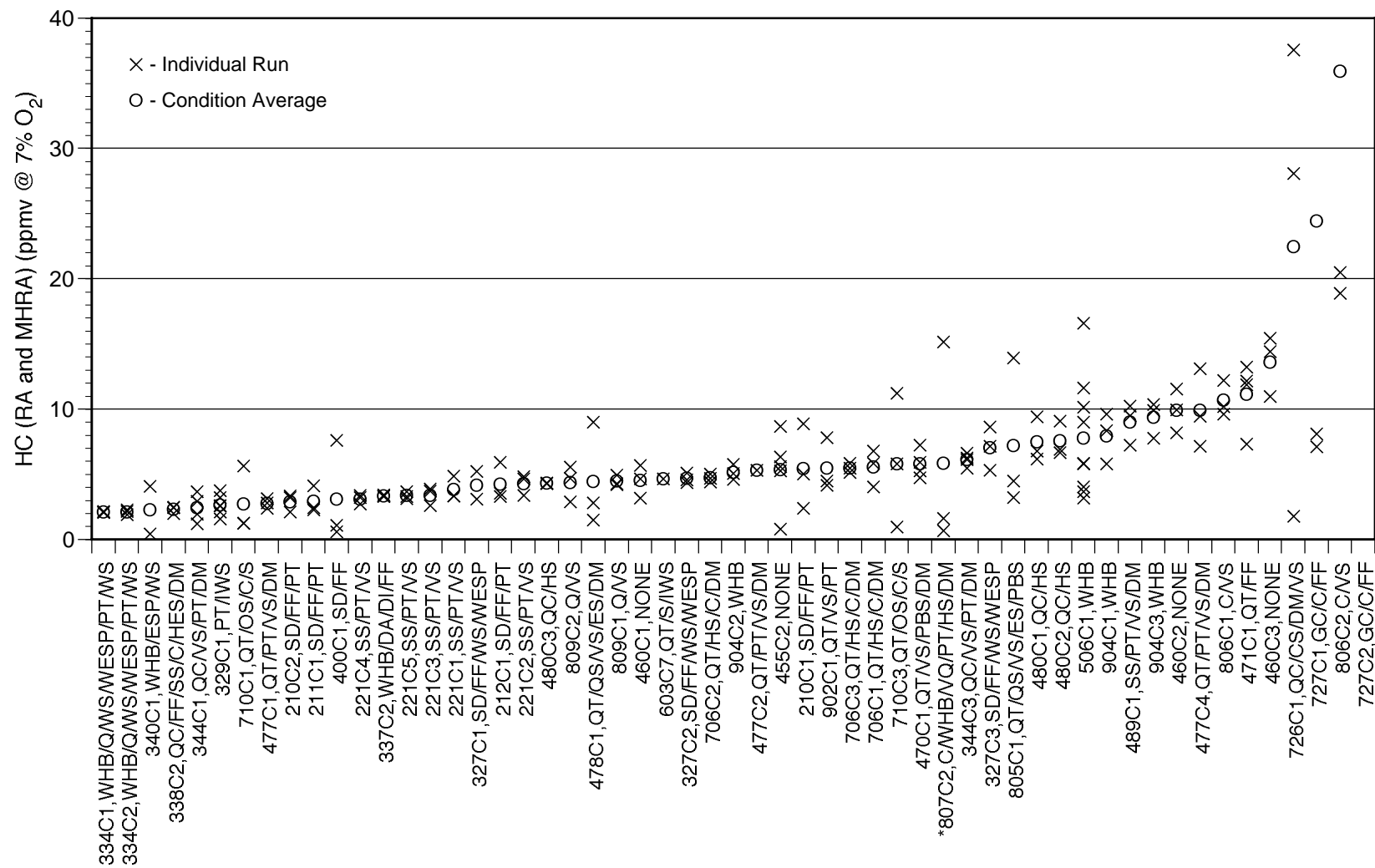


Figure 5-5a. Incinerator hydrocarbon emissions (all FID types) (1 of 2).



*MHRA

Figure 5-5b. Incinerator hydrocarbon emissions (all FID types) (2 of 2).

CHAPTER 6

AGGREGATE FEEDRATE APPROACH RESULTS

As discussed in Chapter 2, the “Aggregate Feedrate” approach is used to identify the MACT defining hazardous waste feedrate, expressed as a maximum theoretical emission concentration (MTEC), for the feedrate-related HAPs including mercury, SVM, LVM, and total chlorine (hydrochloric acid/chlorine gas). Separate Aggregate Feedrate analyses are presented below for each of the three HWC source categories.

6.1 INCINERATORS

Table 6-1 presents hazardous waste feedrate MTECs for all incinerator test conditions where feedrate MTECs are available for all four HAPs (chlorine and metals). In addition, the set is limited to non-baseline test conditions from incinerators that are burning hazardous wastes. The table is divided into two sections.

The first set of test conditions at the top of Table 6-1 uses MACT air pollution control devices (APCDs) for the four feedrate related HAPs. For MACT floor PM control (which is part of both LVM and SVM MACT control) this involves use of either a FF, ESP, or IWS, and meeting a PM floor level of 0.015 gr/dscf, as discussed in Chapters 8 and 9. For MACT floor control for mercury and chlorine, it also requires the use of wet scrubbing, as discussed in Chapters 7 and 10. These test conditions are all considered in the Aggregate Feedrate MTEC analysis. The group consists of 20 test conditions from 9 different incinerators. This includes 6 commercial and 3 on-site incinerators.

Test conditions listed in the second part (below the line) of Table 6-1 are data from sources where hazardous waste feedrate MTECs are available for all four metal/chlorine HAPs. However, these test conditions are not using MACT floor APCDs for either LVM and SVM (PM floor control), chlorine, or mercury. That is to say, they are either not using FF, ESP or IWS and meeting a level of 0.015 gr/dscf, or are not using wet scrubbing. These test conditions are not

considered in the Aggregate Feedrate analysis for determining MACT control defining hazardous waste MTECs. Also, test conditions 601C1 and 601C2 use MACT APCDs, but are not included because they have feedrate MTECs for metals which are unrepresentatively low compared with test condition 601C3.

As described in Chapter 2, the individual HAP hazardous waste MTECs from the first group (above the line) of candidate MACT conditions are ranked from low to high, and assigned a ranking number from 1 to 20, where 1 is assigned to the lowest MTEC, and 20 to the highest MTEC. This individual HAP ranking is shown in the column to the immediate left of each of the HAP MTECs. The composite sum of the four individual HAP rankings is shown in the fourth column from the left for each test condition. The conditions are shown ranked by the HAP composite sum. Again, this group is composed of conditions from facilities which use MACT floor APCDs for the four feedrate related HAPs and contain hazardous waste MTECs for all four HAPs.

Note that only those test conditions where hazardous waste feedrate MTECs are available for all four HAPs are shown in Table 6-1. Test conditions where data are not available for all four HAPs (but may be available for one, two, or three HAPs) are not shown in Table 6-1. However, these data are presented in Chapter 7 to 10 and are considered in setting the subsequent MACT floors for each of the HAPs once the MACT hazardous waste feedrate MTECs have been defined.

Existing Sources

For existing sources, the MACT defining hazardous waste MTECs are the highest MTECs from the best performing sources (those with the lowest composite MTEC ranking) in the first section of Table 6-1. This includes conditions from at least 3 different facilities -- 603C8, 340C2, and 325C5. The MACT MTECs are:

- Hg -- 250 µg/dscm, based on 325C5
- SVM -- 5.3×10^3 µg/dscm, based on 325C5
- LVM -- 2.4×10^4 µg/dscm, based on 340C2
- Chlorine -- 2.2×10^7 µg/dscm, based on 325C5

New Sources

For new sources, the MACT defining hazardous waste MTECs are from the single best controlled source (i.e., the test condition with the lowest aggregate HAP ranking), 603C8, a commercial incinerator:

- Hg -- 110 µg/dscm. We identified the second best test condition as MACT control because the mercury feedrate MTEC of the best performing source is atypically low (three orders of magnitude lower than the MTECs for the other 20 test conditions).
- SVM -- 3.5×10^3 µg/dscm
- LVM -- 1.3×10^4 µg/dscm
- Chlorine -- 4.7×10^6 µg/dscm

6.2 CEMENT KILNS

Similar to that discussed above for incinerators, Table 6-2 shows hazardous waste feedrate MTECs for the four HAPs for cement kilns. Test conditions are limited to those from long and non in-line raw mill cement kilns that are burning hazardous waste (i.e., test conditions from short and in-line raw mill kilns and those that are not currently burning hazardous wastes are not included).

The table is separated into four sections. The first set contains test conditions that have all four HAP hazardous waste MTECs and use MACT APCD floor control for SVM and LVM (PM floor control). PM MACT floor control involves using a FF or ESP and achieving a PM floor level equivalent of 0.03 gr/dscf. Note that unlike incinerators, there are no MACT APCD requirements for chlorine or mercury for cement kilns beyond feedrate control because feedrate control of the hazardous waste is the only control technique used by existing CKs. These test conditions are used in the Aggregate Feedrate approach for setting the MACT feedrate limits. The group includes 12 conditions from 10 different kilns.

The second part also contains test conditions for which all 4 hazardous waste feedrate MTECs are available and which are using MACT floor PM control. However these conditions are not used in the MACT ranking. Conditions marked with “***” in the aggregate ranking column are not used because there are no stack gas mercury measurements associated with these

conditions, and thus mass balance considerations can not be used to determine if the MTECs appear to be accurate. Those with “**” are “normal” conditions.

The third part, marked with an “*”, contains test conditions which are exceeding the PM MACT floor emission level. The last part shows those test conditions for which complete MTEC data for all four HAPs are not available.

Existing Sources

For existing sources, the MACT defining hazardous waste MTECs are from the highest MTECs from the best performing sources. These conditions, from at least 3 different facilities as discussed in Chapter 2, include 208C1 and 207C1 (both from the same facility, Keystone Bath, PA), 320C3, and 335C1. Note that Source ID Nos. 207 and 208 are kilns located at the same facility, therefore 4 conditions from 3 facilities are brought into the MACT pool. We did not want to consider two sources from the same facility as comprising two of the three best performing sources with respect to feedrate control because we are concerned that the hazardous waste feed to the sources may be similar. For example, 208C1 and 207C1 have similar Hg and LVM MTECs. The MACT defining hazardous waste MTECs are:

- Hg -- 88 µg/dscm, based on 335C1
- SVM -- 8.1×10^4 µg/dscm, based on 207C1
- LVM -- 5.4×10^4 µg/dscm, based on 320C3
- Chlorine -- 7.2×10^5 µg/dscm, based on 207C1

Note that as reported in the CoC test burn report, hazardous waste mercury feedrate MTECs from Condition ID Nos. 305C3 and 335C1 are apparently 2.5×10^4 and 1.3×10^5 µg/dscm, respectively, based on hazardous waste mercury concentrations of over 5,000 ppmv. These feedrate MTECs are not considered accurate because:

- The feedrate MTECs (and Hg waste concentrations) are at least 100 times greater than any other CK measurements.
- The feedrate MTECs are higher than SVM and LVM MTECs, which are based on artificially high metals spiked feedstreams.

- Corresponding mercury stack gas emissions are 62 and 5 µg/dscm, which would indicate a SRE of greater than 99.9% for these conditions. The majority of demonstrated CK Hg SREs, as discussed in detail in Chapter 7, are typically 0 to 50%, fully consistent with theoretical considerations.

For this analysis, the hazardous waste MTECs for 335C1 and 305C3 are conservatively projected based on a total Hg SRE of 60%.

New Sources

For new sources, the MACT defining hazardous waste MTECs are from the single best controlled source (i.e., the test condition with the lowest aggregate HAP ranking), 208C1:

- Hg -- 6 µg/dscm
- SVM -- 3.5×10^4 µg/dscm
- LVM -- 1.5×10^4 µg/dscm
- Chlorine -- 4.5×10^5 µg/dscm

6.3 LIGHTWEIGHT AGGREGATE KILNS

Table 6-3 shows hazardous waste feedrate MTECs from the four HAPs for LWAKs. The table contains non-baseline test conditions from facilities burning hazardous waste.

The table is divided into three sections. The first (top) section contains the set of test conditions used in the Aggregate Feedrate approach for setting the MACT hazardous waste feedrate limits. They include those that have all four HAP MTECs and use MACT floor control for PM (which is part of MACT control for SVM and LVM). The MACT PM floor involves use of a FF and meeting a floor level of 0.025 gr/dscf. As for cement kilns, there are no MACT APCD requirements for chlorine or mercury for LWAKs beyond feedrate control because feedrate control of the hazardous waste is the only control technique used by existing LWAKs.

The second part contains test conditions 224C1 and 224C2, which are not considered in the ranking procedure because the feedrate MTECs from this source are not representative of actual

hazardous waste burning operations at the Solite kilns, as per comments from Solite. The third part contains test conditions with insufficient feedrate MTEC data (not available for all four HAPs).

Existing Sources

For existing sources, the MACT defining hazardous waste MTECs are from the highest MTECs from the best performing sources -- with conditions from at least 3 different facilities. These best performing condition ID's are comprised of 475C1 (Brooks, KY site), 311C1 (Cascade, VA site), 310C1 (also from Brooks, KY site), and 225C2 (Norwood, NC site), 314C3 (Arvonnia, VA site), and 312C1 (Cascade, VA) which are tied in rank for the third best performing source (from 3 different facilities). The resulting MTECs are:

- Hg -- 24 µg/dscm, based on 311C1
- SVM -- 2.0×10^6 µg/dscm, based on 310C1
- LVM -- 1.2×10^5 µg/dscm, based on 225C2
- Chlorine -- 2.0×10^6 µg/dscm, based on 312C1

New Sources

For new sources, the MACT defining hazardous waste MTECs are from the single best controlled source, 475C1:

- Hg -- 4 µg/dscm
- SVM -- 3.3×10^5 µg/dscm
- LVM -- 4.6×10^4 µg/dscm
- Chlorine -- 1.2×10^6 µg/dscm

TABLE 6-1. INCINERATOR AGGREGATE FEEDRATE MTEC RANKING

EPA Cond ID	APCS	MACT Control	Agg Rank	HW MTECs (µg/dscm)								Summ Comm	PM gr/dscf	
				Ra	Hg	Ra	SVM	Ra	LVM	Ra	TCI			
Conditions using MACT control and 4 feedrate MTECs														
603C8	QT/S/IWS	y	11	1	7.2E-02	1	3.5E+03	5	1.3E+04	4	4.7E+06	MACT source	0.002	
340C2	WHB/ESP/WS	y	14	4	1.1E+02	2	3.7E+03	7	2.4E+04	1	2.9E+06		MACT source	0.005
325C5	SD/FF/WS/IWS	y	22	8	2.5E+02	4	5.3E+03	1	2.4E+03	9	2.2E+07		MACT source	0.004
340C1	WHB/ESP/WS	y	23	5	1.3E+02	5	5.7E+03	10	3.6E+04	3	4.4E+06			0.008
325C4	SD/FF/WS/IWS	y	23	2	6.3E+01	3	4.7E+03	3	3.9E+03	15	2.4E+07			0.004
325C7	SD/FF/WS/IWS	y	28	3	7.9E+01	7	9.0E+03	2	3.2E+03	16	3.1E+07		0.005	
325C6	SD/FF/WS/IWS	y	29	6	1.5E+02	6	6.2E+03	4	6.8E+03	13	2.4E+07		0.002	
222B3	WHB/SD/CI/ESP/Q/PBS	y	34	9	2.5E+02	14	1.5E+05	9	3.0E+04	2	4.0E+06		0.003	
602C2	Q/S/C/DM/HEPA	y	36	11	1.2E+03	9	5.1E+04	11	5.3E+04	5	1.0E+07		0.002	
602C1	Q/S/C/DM/HEPA	y	43	15	5.3E+03	10	5.4E+04	12	5.7E+04	6	1.1E+07		0.002	
602C3	Q/S/C/DM/HEPA	y	45	14	4.2E+03	11	6.7E+04	13	6.8E+04	7	1.2E+07		0.002	
354C1	QC/AS/VS/DM/IWS	y	47	13	1.8E+03	8	2.6E+04	6	1.4E+04	20	4.4E+07		0.001	
209C1	WHB/FF/VQ/PT/DM	y	51	7	2.4E+02	13	1.3E+05	14	8.3E+04	17	3.8E+07		0.001	
354C5	QC/AS/VS/DM/IWS	y	51	12	1.6E+03	12	7.6E+04	8	2.5E+04	19	4.0E+07		0.001	
209C2	WHB/FF/VQ/PT/DM	y	58	10	2.5E+02	15	1.7E+05	15	9.8E+04	18	4.0E+07		0.001	
327C3	SD/FF/WS/WESP	y	59	16	9.4E+03	17	3.2E+05	16	1.7E+05	10	2.2E+07		0.001	
327C2	SD/FF/WS/WESP	y	64	17	1.3E+04	16	2.1E+05	17	2.5E+05	14	2.4E+07		0.002	
601C3	WHB/DS/FF/WS	y	67	20	7.6E+04	20	1.5E+06	19	7.6E+05	8	1.8E+07		0.003	
327C1	SD/FF/WS/WESP	y	67	19	2.1E+04	19	9.3E+05	18	4.4E+05	11	2.2E+07		0.001	
222C1	WHB/SD/CI/ESP/Q/PBS	y	68	18	1.4E+04	18	7.9E+05	20	1.3E+06	12	2.3E+07		0.003	
Conditions not using MACT and 4 feedrate MTECs														
214C2	Q/IWS	n			2.1E+03		2.2E+05		5.7E+04		2.8E+07		0.028	
214C3	Q/IWS	n			3.4E+03		3.4E+05		8.8E+04		2.9E+07		0.019	
221C1	SS/PT/VS	n			6.0E+00		1.4E+02		7.2E+01		2.5E+07		0.014	
221C2	SS/PT/VS	n			2.4E+01		4.6E+03		9.3E+02		3.1E+07		0.015	
221C3	SS/PT/VS	n			2.8E+01		2.1E+03		1.2E+04		3.1E+07		0.013	
221C4	SS/PT/VS	n			7.7E+00		3.6E+02		3.5E+02		2.9E+07		0.015	

TABLE 6-1. INCINERATOR AGGREGATE FEEDRATE MTEC RANKING

EPA Cond ID	APCS	MACT Control	Agg Rank	HW MTECs (µg/dscm)								Summ Comm	PM gr/dscf
				Ra	Hg	Ra	SVM	Ra	LVM	Ra	TCI		
221C5	SS/PT/VS	n			5.0E+01		1.3E+03		9.6E+03		3.3E+07		0.013
334C1	WHB/Q/WS/WESP/PT/W	n			3.0E+02		1.2E+05		1.6E+04		4.0E+06		0.062
334C2	WHB/Q/WS/WESP/PT/W	n			3.0E+01		5.1E+02		4.9E+03		9.1E+06		0.058
337C1	WHB/DA/DI/FF	n			6.1E+01		4.2E+04		2.5E+03		1.3E+05		0.000
341C1	DA/DI/FF/HEPA/CA	n			5.3E+00		2.5E+02		3.3E+02		5.0E+06		0.003
341C2	DA/DI/FF/HEPA/CA	n			8.4E+00		2.3E+02		6.6E+02		2.3E+06		0.001
458C2	VS/PT/QT	n			4.5E+02		2.6E+04		3.8E+04		9.5E+07		0.018
488C1	SS/PT/VS/DM	n			1.2E+01		1.4E+03		1.1E+06		8.8E+06		0.013
488C2	SS/PT/VS/DM	n			1.7E+01		6.3E+02		9.1E+05		1.6E+07		0.010
488C3	SS/PT/VS/DM	n			1.3E+01		1.1E+03		1.7E+06		3.4E+07		0.008
489C1	SS/PT/VS/DM	n			1.4E+02		1.6E+04		5.8E+05		1.6E+07		0.013
490C1	SS/PBS	n			1.8E+01		1.5E+03		2.0E+04		3.6E+06		0.011
504C1	VS/C	n			3.6E+03		2.5E+04		1.2E+05		1.5E+05		0.021
700C1	SD/RJS/VS/WS	n			3.5E+00		2.2E+05		6.6E+03		3.1E+06		0.057
705C1	QT/VS/PT/WESP	n			4.6E-02		4.3E-01		5.1E-01		8.2E+06		0.025
705C2	QT/VS/PT/WESP	n			6.3E+00		2.1E+02		1.0E+03		2.6E+06		0.052
824C1	QT/VS/PT/DM	n			5.0E+00		3.6E+02		8.4E+03		4.9E+06		0.006
601C1	WHB/DS/FF/WS	y			5.3E+01		4.1E+03		1.1E+04		1.8E+07		0.005
601C2	WHB/DS/FF/WS	y			2.1E+02		8.1E+03		7.2E+03		1.8E+07		0.011

TABLE 6-2. CEMENT KILNS AGGREGATE FEEDRATE MTEC RANKING

EPA	Agg	HW MTEC (µg/dscm)								Summary	PM
Cond ID	Rank	Rank	Hg	Rank	SVM	Rank	LVM	Rank	Cl	Comments	gr/dscf
Conditions with MACT control and 4 feedrate MTECs											
208C1	5	1	6	1	3.5E+04	1	1.5E+04	2	4.5E+05	MACT source 1a	0.014
207C1	13	2	6	5	8.1E+04	2	1.6E+04	4	7.2E+05	MACT source 1b	0.028
320C3	15	6	30	3	6.6E+04	5	5.4E+04	1	3.2E+05	MACT source 2	0.002
335C1	21	11	88	4	7.5E+04	3	3.9E+04	3	4.6E+05	MACT source 3	0.023
203C1	23	3	11	10	1.6E+05	4	4.7E+04	6	1.4E+06		0.014
404C1	25	5	27	2	6.2E+04	10	1.7E+05	8	1.7E+06		0.007
206C1	28	4	19	11	1.6E+05	8	1.6E+05	5	9.8E+05		0.023
403C1	29	7	61	6	1.2E+05	9	1.6E+05	7	1.6E+06		0.029
322C8	34	8	70	8	1.3E+05	7	1.3E+05	11	3.0E+06		0.013
323B3	37	12	111	7	1.2E+05	6	1.1E+05	12	3.7E+06		0.026
403C3	40	9	82	9	1.6E+05	12	1.9E+05	10	2.3E+06		0.029
404C4	42	10	87	12	1.7E+05	11	1.8E+05	9	2.1E+06		0.004
Conditions with MACT control but not used for Aggregate Ranking											
200C5	***		49		3.2E+05		5.1E+05		3.5E+06	No Hg stack gas	0.002
320C1	***		6		3.3E+04		2.5E+04		3.3E+05	No Hg stack gas	0.003
322C1	***		32		1.4E+05		1.7E+05		3.0E+06	No Hg stack gas	0.019
323C1	***		18		1.4E+05		2.0E+05		3.7E+06	No Hg stack gas	0.022
200C4	***		58		2.1E+05		3.2E+05		2.0E+06	No Hg stack gas	0.004
208C2	***		1		1.6E+04		7.2E+03		6.5E+04	No Hg stack gas	0.016
207C2	***		5		4.9E+04		1.4E+04		4.2E+05	No Hg stack gas	0.018
323C9	**		26		2.0E+04		1.3E+04		5.0E+05	Normal cond.	0.005
323B2	**		92		1.8E+04		9.9E+03		6.5E+05	Normal cond.	0.020
Conditions with 4 feedrate MTECs but not using MACT control											
402C1	*		117		2.1E+05		2.0E+05		2.8E+06	PM > 0.03	0.033
302C1	*		36		4.1E+05		2.0E+05		2.5E+06	PM > 0.03	0.034
204C1	*		2		2.2E+05		1.5E+05		2.5E+06	PM > 0.03	0.034
319C1	*		2		2.0E+05		2.0E+05		1.4E+06	PM > 0.03	0.037

TABLE 6-2. CEMENT KILNS AGGREGATE FEEDRATE MTEC RANKING

EPA Cond ID	Agg Rank	HW MTEC (µg/dscm)								Summary	PM gr/dscf
		Rank	Hg	Rank	SVM	Rank	LVM	Rank	CI	Comments	
401C1	*		544		7.4E+04		3.0E+04		3.7E+06	PM > 0.03	0.048
205C1	*		10		1.4E+05		1.3E+05		5.4E+05	PM > 0.03	0.050
304C1	*		9		1.4E+05		1.7E+05		5.6E+05	PM > 0.03	0.056
302C3	*		51		4.5E+05		3.1E+05		4.4E+06	PM > 0.03	0.060
491C1	*		360		2.3E+05		2.5E+05		2.2E+06	PM > 0.03	0.063
305C1	*		30		1.6E+05		8.8E+04		1.3E+06	PM > 0.03	0.063
401C5	*		47		1.5E+05		1.2E+04		1.8E+06	PM > 0.03	0.077
305C3	*		25		6.8E+04		4.4E+04		4.4E+05	PM > 0.03	0.077
402C4	*		30		4.2E+04		1.8E+04		2.6E+06	PM ?	
319D6	*		20		1.6E+05		1.5E+05		2.1E+06	PM?	

TABLE 6-3. LWAK AGGREGATE FEEDRATE MTEC RANKING

EPA Cond ID	Agg Rank	HW MTECs (µg/dscm)								Summ Comm	PM gr/dscf
		Rank	Hg	Rank	SVM	Rank	LVM	Rank	TCI		
Used for Aggregate Analysis											
475C1	17	4	4	5	3.3E+05	4	4.6E+04	4	1.2E+06	MACT source 1	0.003
311C1	26	15	24	6	3.7E+05	2	4.0E+04	3	9.0E+05	MACT source 2	0.006
310C1	33	10	9	20	2.0E+06	1	2.8E+04	2	7.6E+05	MACT source 1	0.018
225C2	36	5	5	7	3.9E+05	17	1.2E+05	7	1.5E+06	MACT source 3 tie	0.001
314C3	36	1	0	11	5.7E+05	16	9.5E+04	8	1.5E+06	MACT source 4 tie	0.003
312C1	36	12	12	8	4.6E+05	5	4.6E+04	11	2.0E+06	MACT source 2 tie	0.010
310C2	37	6	6	10	5.4E+05	20	1.8E+05	1	4.8E+05		0.012
226C2	39	2	0	9	5.1E+05	18	1.4E+05	10	1.9E+06		0.002
608C1	40	3	2	12	5.8E+05	19	1.4E+05	6	1.4E+06		0.010
474C1	42	9	7	16	7.2E+05	12	6.4E+04	5	1.4E+06		0.003
307C3	42	17	2027	4	5.8E+04	3	4.5E+04	18	7.8E+06		0.022
225C1	45	7	7	13	6.6E+05	13	7.1E+04	12	2.0E+06		0.001
307C2	45	18	2181	1	5.2E+04	6	4.6E+04	20	1.4E+07		0.010
307C4	47	19	2273	2	5.5E+04	7	4.8E+04	19	1.2E+07		0.007
314C1	48	16	64	15	7.0E+05	8	5.0E+04	9	1.6E+06		0.025
307C1	49	20	2369	3	5.7E+04	9	5.0E+04	17	3.4E+06		0.008
313C1	51	14	17	14	6.9E+05	10	6.1E+04	13	2.1E+06		0.007
476C1	55	11	10	19	8.2E+05	11	6.2E+04	14	2.1E+06		0.020
226C1	57	8	7	18	7.4E+05	15	8.6E+04	16	3.2E+06		0.002
223C1	59	13	17	17	7.3E+05	14	7.1E+04	15	2.4E+06		0.004
Non representative feedrate MTECs											
224C2			11		6.6E+03		2.6E+03		2.4E+05	Non repr. MTECs	0.001
224C1			9		1.5E+04		5.6E+03		8.5E+05	Non repr. MTECs	0.005
Incomplete feedrate MTECs											
336C1									1.4E+06		
336C2									1.4E+06		

CHAPTER 7

MERCURY

7.1 INCINERATORS

Table 7-1 summarizes all mercury test condition data from HWIs, ranked by mercury hazardous waste feedrate MTEC. The data are from about 30 different HWIs. Stack gas emissions condition averages range very widely from 0.1 to 60,000 $\mu\text{g}/\text{dscm}$, due to variations in mercury feedrates and APCS performance, as discussed below. Table 7-1 is separated into two parts. The first section contains test conditions from incinerators which are currently burning hazardous waste. They are ranked by hazardous waste mercury feedrate MTEC, from low to high. Conditions that do not have mercury feedrates are included below those that do. The second section contains test conditions from incinerators that are no longer burning hazardous wastes.

Mercury emissions from existing HWIs are controlled through feedrate and/or use of air pollution control devices, including wet scrubbing and activated carbon adsorption. Nearly all incinerators use wet scrubbing, primarily (or originally) intended for acid gas control. However, wet scrubbers may also be effective at controlling mercury. Mercury SREs for incinerators with wet scrubbers are shown in Figure 7-1. Wet scrubbing systems have a wide range of mercury SREs, from 0 to greater than 99%. In many cases, negative SREs are likely due to errors in the feedrate MTEC or stack gas measurements. Additionally, most of the test conditions where the SRE is negative are associated with very low feedrate or stack gas levels, where the uncertainty in the mass balance measurements tends to become larger.

The wide range of mercury control by wet scrubbers may be attributed to a variety of factors including:

- Mercury speciation -- Hg control in wet scrubbers is highly dependent on the Hg speciation in the flue gas. Hg in incinerator flue gases can be in various forms, depending on factors

including the waste composition (in particular chlorine and sulfur levels), flue gas temperature profile, and NO_x level. Typical Hg forms include:

- Elemental Hg (Hg^0) -- If chlorine is not present or sulfur levels are high, Hg^0 can be a significant fraction of the total Hg level. The HWI data show that Hg^0 is generally not well-controlled by wet scrubbers, as demonstrated in various pilot scale experimental studies. This is because it is highly volatile and not soluble in water. Additionally, wet scrubbers have achieved limited control of mercury from systems where Hg^0 dominates, such as certain coal fired boilers.
- Mercuric chloride (HgCl_2) -- HgCl_2 is the thermodynamically favored form in the combustion system when chlorine is present. HgCl_2 is highly volatile but, unlike Hg^0 , is soluble in water and it is readily captured by wet scrubbers. Some wet scrubber systems have demonstrated greater than 90% control of total Hg on incinerators burning chlorinated wastes (e.g., 327C1, 327C2, 327C3, 214C2, 214C3, 354C1, 354C5, 334C1).
- Mercuric oxide (HgO) -- This is not usually a significant form because the reaction rate is slow.
- Others -- Hg can be in other forms (usually in smaller concentrations), such as mercurous chloride (Hg_2Cl_2) or methylmercury chloride (CH_3HgCl).

The flue gas temperature profile (gas quenching rate) has also been shown to affect Hg speciation (Gaspar et al., 1997). In particular, rapid quenching of the flue gases, as done in wet scrubbing APCSSs, may be undesirable because it can act to inhibit the full potential formation of HgCl_2 . Slow gas cooling, allowing equilibrium conditions to be achieved, has been shown to maximize the levels of soluble HgCl_2 and hence increase the wet scrubber control performance.

- Wet scrubber operating parameters -- Scrubber liquor pH has been suggested to affect Hg control in wet scrubbers. For wet scrubbers with basic reducing scrubber liquors (pH greater than 7), soluble HgCl_2 absorbed in the scrubber liquor can be reduced to Hg^0 , in particular by sulfite ions that have been absorbed in the liquor. The Hg^0 can be revolatilized back to the flue gas when the liquor is recirculated to the scrubber, as is typically done (few units use “single” pass scrubbing). This has been confirmed through simultaneous flue gas Hg speciation measurements, showing that wet scrubber outlet Hg

levels are higher than inlet measurements. In these tests, the wet scrubber Hg^0 capture efficiency is less than 0%, indicating Hg^0 is being “formed” in the wet scrubber.

The operation of two scrubbers in series has been suggested to reduce this potential problem. The first stage of the scrubber is operated with an acidic, oxidizing scrubber solution (pH less than 7). This degrades the scrubber acid gas control performance, particularly for SO_2 . However, in an acidic solution, the captured HgCl_2 is transformed primarily to HgCl_4 , which is stable and not easily reduced to Hg^0 . The second scrubber can then be operated with a basic pH to capture additional acid gases (HCl and SO_2) that were not effectively removed in the first scrubber.

Scrubber liquor additives, such as strong oxidizing agents like sodium chlorite or potassium permanganate (and scrubbers with low pH levels) can also be used to convert Hg^0 to oxidized soluble Hg forms, such as HgCl_2 . These forms are soluble in the wet scrubber solutions.

Generally, existing HWI wet scrubber SREs range from 15 to 60% for conditions where active mercury spiking took place. Some of these conditions are summarized in Table 7-2. Note that feedrates and SREs are likely to be more accurate for these conditions because mercury spiking was conducted. These units all use “single” stage scrubbers, where the scrubber liquor pH is most likely kept greater than 7 (basic). Performance of the units includes:

- Three units (Laidlaw Clive (ID No. 601), WTI (ID No. 222), and Savannah River CIF (ID No. 602)) spiked large amounts of mercury and showed little (0 to 15%) mercury control. This is potentially surprising because two of the units had both high levels of chlorine and used waste heat boilers (slow gas cooling profile). As discussed above, these factors might indicate the potential for high levels of Hg control with wet scrubbing. Revolatilization from scrubber liquor pH and recirculation are potential reasons for poor control performance.
- Two units (Chevron and Ciba), also spiking large amounts of Hg, showed moderate (40%) mercury control. Neither had high chlorine levels. Both used rapid quench gas cooling.
- Three units (Norlite LWAK, EPA IRF, Oak Ridge K-25 TSCA (ID No. 357),) showed good mercury control (75 to 90%).

- The Norlite LWAK (ID No. 307) had medium Hg spiking, high chlorine, and slow gas cooling, supporting the good control being achieved. Note that the mercury control performance of wet scrubbing on a hazardous waste burning lightweight aggregate kiln is directly transferrable and relevant to that expected at hazardous waste incinerators.
- The EPA IRF testing was a pilot scale parametric evaluation of Hg control with a Calvert Collision Wet Scrubber. Hg was spiked at a relatively low level (MTEC of 300 µg/dscm) compared with the other tests. Chlorine was varied from 0 to 4% by weight in the feed input. Wet scrubber mercury control improved with decreasing chlorine feed levels, opposite to what would be expected.
- The Oak Ridge K-25 TSCA unit had very low levels of Hg feed (MTEC of 10 µg/dscm). Hg spiking was not conducted. Feed input Hg measurement levels, including heterogeneous solid waste, were below 0.2 ppmw. The assessment of Hg control efficiencies at these very low feedrate levels is difficult (or impossible) due to the uncertainty in the feedrate and stack gas measurements. Thus, these results must be viewed with caution.

Activated carbon adsorption-based control methods are used on three sources. A carbon bed is used on one facility, Source ID No. 341, where it is difficult to assess its mercury control performance with available data. Carbon injection is used on Source ID No. 222 on a full time basis and on Source ID No. 601 on an experimental basis. Greater than 97% mercury control is being consistently demonstrated with carbon injection at these sources.

Efficient capture of the injected carbon (typically in a ESP or FF PM control device) is critical to the performance. However, without carbon injection, there is no influence of the generally more efficient PM control devices such as ESP and FFs on incinerator Hg control (i.e., systems with ESP and FFs do not generally have better mercury control than those with only wet scrubbers). This is consistent with theory that predicts poor mercury control when mercury is primarily in the vapor due to its high volatility and coupled with the fact that there are low levels of unburned carbon present in the hazardous waste incinerator fly ash to adsorb the volatile mercury.

7.1.1 Existing Sources Floor

The best performing sources (lowest stack gas emissions concentration levels) generally have low hazardous waste feedrate MTECs (less than 300 µg/dscm) and use different

combinations of wet scrubbing APCD systems (e.g., venturis, packed towers, ionizing wet scrubbers). Thus, the MACT floor for mercury for existing sources is based on feedrate control and the use of wet scrubbing. The MACT mercury hazardous waste feedrate MTEC is set at 250 µg/dscm, based on the Aggregate Feedrate results discussed in Chapter 6. The MACT floor for Hg is set at 130 µg/dscm, based on Source ID No. 601C2. This corresponds to the highest emitting condition using MACT control of both wet scrubbing and hazardous waste feedrate of less than the MACT defining MTEC. Note that:

- About 70% of the mercury hazardous waste MTECs are less than the MACT defining level of 249 µg/dscm. There are a wide range of mercury feedrate MTECs. Most of the lower feedrate conditions of less than 300 µg/dscm are “normal” with respect to hazardous waste mercury content (i.e., no mercury spiking). Alternatively, tests conditions conducted with active mercury spiking have mercury emissions levels ranging from 1,000 all the way up to 70,000 µg/dscm.
- About 80% of the Hg stack gas emissions levels are less than the MACT floor level of 126 µg/dscm. Most of those that are higher are from test conditions where active Hg spiking took place.

Also, Source ID No. 337C1 was not considered for setting the floor. It has an apparent feedrate MTEC of 69 µg/dscm with a corresponding emissions level of 173 µg/dscm. Because the SRE is negative, there must be an error in either the feedrate MTEC or stack gas emissions measurements.

7.1.2 New Sources Floor

MACT for new sources is based similarly to that for existing sources on the use of wet scrubbing and hazardous waste mercury feedrate control. The MACT floor mercury hazardous waste feedrate MTEC for new sources is set at 110 µg/dscm, based on the Aggregate Feedrate MTEC results discussed in Chapter 6. The resulting MACT floor for Hg is set at 45 µg/dscm. This is the highest condition using MACT control.

Note that the use of carbon injection was also considered for evaluating the MACT floor. Carbon injection typically performs better and more consistently than wet scrubbing for mercury control and is used on the prerequisite single existing source. For a mercury feedrate of 300 µg/dscm, based on the upper end of the hazardous waste-only (i.e., no spiking) mercury feedrate MTEC data and a conservative carbon injection mercury control efficiency of 85%, a level of about

45 µg/dscm results. This emission level is consistent with the floor level based on the Aggregate Feedrate and wet scrubbing approach.

7.2 CEMENT KILNS

Table 7-3 summarizes all mercury test condition data from CKs, ranked by hazardous waste feedrate MTEC. The data are from about 25 different CKs. Stack gas condition averages range widely from 3 to 3,000 µg/dscm, with the majority less than about 150 µg/dscm. The table is divided into 3 sections. The first section contains test conditions from long kilns without in-line raw mills that are currently burning hazardous waste. The test conditions are ranked by hazardous waste mercury feedrate MTEC. The second section contains test conditions from short kilns and those with in-line raw mills. The third section contains test conditions from kilns no longer burning hazardous wastes.

Of the mercury data in the HWC data base, almost all CKs demonstrated compliance with the current BIF rules under the Tier I option. Tier I assumes that all metals present in feedstreams are emitted to the atmosphere (i.e., SRE is 0%) and no stack gas emissions testing is required. Thus, most of the mercury stack gas data were not used directly for compliance purposes. Instead, they were included in the results from the multiple metals train used for determining other metals emissions rates. The CoC emissions data are generally considered “normal” with respect to hazardous waste mercury content. No mercury spiking was conducted by any of these Tier I facilities.

Of the CKs currently burning hazardous waste, the only CK that tested under BIF’s Tier III option was Source ID No. 303 (LoneStar, Cape Girardeau). Under Tier III, emissions testing is used to determine system control performance. The Tier classification is unclear for ID No. 473 (Texas Industries, Midlothian, TX). EPA’s HWC database indicates that significant mercury spiking was only conducted for Source ID No. 306. However, this source no longer burns hazardous waste and is not part of the MACT analysis. Nonetheless, the following discussion is provided for information purposes because the data are shown in Table 7-3. Based on CoC and trial burn report data, it is not possible to determine the amount of spiking for ID No. 306. Only the total attributable to the hazardous waste and spiking streams is reported. Further assessment of this facility determined that under normal operations, this source’s mercury feedrates are considerably lower than the CoC testing feedrates. It is estimated that the facility has a waste feed MTEC of 200 µg/dscm, which is typical of the other hazardous waste burning cement kilns, and a total emissions level of 600 µg/dscm when considering mercury from the raw materials and

supplemental fossil fuels. An emissions level of 3,000 µg/dscm was measured during the CoC testing when Hg was spiked.

Mercury SREs in CKs range from 0 to more than 90%. However, Hg is generally regarded as “uncontrolled” once in the cement kiln system, regardless of the system type (long vs short, wet vs dry, etc.). Hg fed to the kiln volatilizes and primarily partitions to the stack gas. Mercury is generally volatile at typical APCD temperatures and is not typically contained in the clinker or CKD unless the CKD has elevated carbon content which may adsorb mercury. Typical CKD has low carbon levels. The higher mercury SREs for some test conditions are likely due to measurement uncertainties associated with very low levels of mercury in the stack gas or feed streams. The most representative SRE for cement kilns appears to be from Source ID No. 306 (National Cement, which is no longer burning hazardous wastes) at about 10%, where well-characterized (and large) amounts of mercury were spiked.

For short kilns with separate alkali bypass stacks, the bypass flue gas has a mercury gas concentration level that is directly representative of inputs upstream of the bypass take off (e.g., fuels that are used for kiln firing, which may include both fossil fuel and hazardous waste mercury contributions). Alternatively, the main stack mercury levels will contain mercury from fossil and waste fuels and additional contributions from raw materials. Thus, the main stack mercury levels should be higher than bypass levels, the balance being the difference in raw materials contributions. This holds true for the Source ID No. 301 (this kiln is no longer burning hazardous waste), which has a main stack level of about 115 µg/dscm and a bypass level of 50 µg/dscm. This is also true for two test conditions of Source ID No. 321 (321C3 and 321C4, but not 321C5).

Based on very limited data, mercury emissions from cement kilns using heated in-line raw mills (ILRMs) may correlate to the operational status of the raw mill. Three kilns currently burning hazardous wastes use ILRMs (Source ID Nos. 303, 321, and 202). Only Source ID No. 303 has Hg stack gas data with and without the raw mill in operation. Comparison of mercury testing at Source ID No. 303 with and without the raw mill on-line showed that emissions are lower when the mill was on-line, possibly due to enhanced mercury capture at lower raw mill flue gas temperatures and raw mill dust filtering. An alternate argument can be made that mercury levels without the ILRM in operation should be lower. During operation with the raw mill off-line, stored raw materials are used which have been previously heated during ILRM operations, providing the opportunity to drive off some mercury. Generally, kiln operation is conducted with the ILRM on-line more than 90% of the time.

7.2.1 Existing Sources Floor

Mercury is not currently actively controlled through specific add-on controls in cement kilns. Instead, mercury is controlled in cement kilns through limiting mercury in the hazardous waste feed. The MACT defining feedrate hazardous waste MTEC, based on the Aggregate Feedrate approach presented in Chapter 6, is 88 µg/dscm. The resulting CK mercury MACT floor is 120 µg/dscm, based on Source ID No. 404C4. Note that:

- 90% of all of the stack gas data are less than 100 µg/dscm and 80% are less than 50 µg/dscm.
- Mercury hazardous waste feedrate MTECs range from less than 1 to 100,000 µg/dscm, with about 80% less than 87 µg/dscm. Therefore, for most cases, the mercury content of the hazardous waste fired by CKs in past CoCs is not by itself projected to result in emissions above the floor.
- Mercury feedrate MTECs attributable to raw materials and coal streams range from 50 to 400 µg/dscm (those that are fully detected), with one outlier at 1,100 and about 75% less than 70 µg/dscm. These are shown in the “other” MTEC column. Compliance with “Alternative Standards” provisions of the MACT rule may be appropriate for some limited cases where it is shown that raw materials metals (and chlorine) levels are contributing to the source’s inability to meet the MACT standards.
- The short and in-line raw mill cement kilns meet the floor of 120 µg/dscm:
 - Source ID No. 202 (long kiln) has two sets of Hg data, both with the in-line raw mill not operating, less than 20 µg/dscm. Note that this may be a high upper end for mercury. With the raw mill in operation, Hg emissions may be even lower.
 - Source ID No. 303 (short kiln with combined bypass and main stack) has data indicating Hg emissions with the in-line raw mill on are lower than that with it off (45 vs 299 µg/dscm from 12/95 testing). Based on Lonestar May 1997 NODA comments, the kiln is operated 88% of time with the in-line raw mill on. The resulting main and bypass flow/mass weighted average is 76 µg/dscm.
 - Source ID No. 321 (short kiln with separate bypass and main stacks) has a bypass/main stack weighted average Hg level of 93 µg/dscm with the raw mill on,

based on 8/95 data (19 µg/dscm at bypass and 105 µg/dscm at main). Also, lower stack gas Hg data from earlier test conditions are available.

The mercury emissions floor is higher than the MACT defining hazardous waste feedrate MTEC. This is because of the contribution of the mercury content of the cement kiln raw materials/or coal.

7.2.2 New Sources Floor

Similar to existing sources, MACT for new sources is based on the control of mercury in the hazardous waste. The MACT floor defining hazardous waste feedrate MTEC, based on the Aggregate Feedrate approach presented in Chapter 6, is 7 µg/dscm. The resulting MACT floor for mercury for new sources is 56 µg/dscm.

7.3 LIGHTWEIGHT AGGREGATE KILNS

Table 7-4 summarizes all mercury test condition data from LWAKs, ranked by hazardous waste MTEC. The data are from fifteen different LWAKs. Stack gas condition averages range widely from 0.4 to 560 µg/dscm. All kilns except one have levels less than about 50 µg/dscm.

Similar to cement kilns discussed above, for all the Solite kilns, mercury is under the BIF Tier I (or Adjusted Tier I) compliance option. As concluded for CKs, these Solite emissions data are likely “normal” with respect to hazardous waste mercury content.

Alternatively, the highest emitting facility Norlite Source ID No. 307, with 4 test conditions and levels from 400 to 500 µg/dscm, tested under Tier III compliance. Unlike Tier I, under Tier III stack gas measurement levels are used to determine compliance. Mercury spiking was conducted at hazardous waste feedrate MTEC levels of about 2,000 µg/dscm. Note that under normal operations, mercury is rarely detected in the hazardous waste, based on communications with the facility. Thus, for risk assessment purposes, a lower projected mercury emissions level is used, based on normal waste mercury content.

For the Solite LWAKs which use APCs that have FFs only, mercury is controlled through hazardous waste feedrate, like cement kilns. SREs of above 80% for some of these facilities would indicate that mercury is controlled through other means (i.e., it would appear that mercury is either being removed in the LWA product or perhaps by the FF). However, this is more likely an artifact of the low mercury feedrates, making it difficult to reliably determine SREs

due to non-detect feedrate measurements and the measurement inaccuracies for heterogeneous waste and raw material feeds.

Source ID No. 307 and another kiln at the same site use venturi scrubbers, which have a consistent performance of 75 to 80% mercury control. These SREs are considered more reliable because mercury spiking occurred.

7.3.1 Existing Sources Floor

MACT control for mercury in LWAKs, like cement kilns, is based on hazardous waste mercury feedrate control. The MACT floor defining hazardous waste MTEC, based on the Aggregate Feedrate MTEC approach of Chapter 6, is 24 µg/dscm. The resulting LWAK Hg MACT floor is 47 µg/dscm. This is the highest non-spiked LWAK Hg stack gas emissions measurement.

Note that hazardous waste Hg feedrate MTECs are from 5 to 25 µg/dscm, with one at 60. For the Solite kilns, raw materials Hg feedrate MTECs are all comparable (from about 10 to 75 µg/dscm). For the Norlite kiln, raw materials Hg feedrate MTECs are about 75 to 90 µg/dscm.

7.3.2 New Sources Floor

Similar to existing sources, MACT for new sources is based on the control of mercury in the hazardous waste. The MACT defining hazardous waste MTEC, based on the Aggregate Feedrate MTEC approach of Chapter 6, is 4 µg/dscm. The resulting LWAK Hg MACT floor is 33 µg/dscm.

TABLE 7-1. INCINERATOR MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	Size Class	Syst Type
		Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)				
Part 1. Facilities burning hazardous waste											
705C1	QT/VS/PT/WESP	4	22		4.6E-02	100		-9023	MB prob	L	OS
603C8	QT/S/IWS	5		0.01	7.2E-02	100		-7245	MB prob	L	Comm
700C1	SD/RJS/VS/WS	5		1	3.5E+00	100	2	-34		L	OS
824C1	QT/VS/PT/DM	1			5.0E+00	3		85		S	OS
341C1	DA/DI/FF/HEPA/CA	1	100		5.3E+00	100		75		S	OS
221C1	SS/PT/VS	5			6.0E+00	59		23		L	Comm
705C2	QT/VS/PT/WESP	25			6.3E+00	100		-297	MB prob	L	OS
221C4	SS/PT/VS	18			7.7E+00	100		-131	MB prob	L	Comm
341C2	DA/DI/FF/HEPA/CA	1	100		8.4E+00	42		85		S	OS
488C1	SS/PT/VS/DM	12			1.2E+01	12		4		L	Comm
488C3	SS/PT/VS/DM	2			1.3E+01	16		86		L	Comm
488C2	SS/PT/VS/DM	10			1.7E+01	7		44		L	Comm
490C1	SS/PBS	28			1.8E+01	68		-50		L	OS
221C2	SS/PT/VS	27			2.4E+01	37		-11		L	Comm
221C3	SS/PT/VS	0.1			2.8E+01	40		100		L	Comm
334C2	WS/WESP/PT	4			3.0E+01	40		87		L	OS
221C5	SS/PT/VS	0.1			5.0E+01	4		100		L	Comm
601C1	DS/FF/WS	33	36		5.3E+01			38		L	Comm
337C1	WHB/DA/DI/FF	173			6.1E+01	7		-182	MB prob	S	OS
325C4	SD/FF/WS/IWS	45			6.3E+01			29		L	Comm
325C7	SD/FF/WS/IWS	24			7.9E+01			69		L	Comm
340C2	WHB/ESP/WS	12			1.1E+02	40		89		S	OS
340C1	WHB/ESP/WS	7			1.3E+02	53		94		S	OS
489C1	SS/PT/VS/DM	22			1.4E+02	3		84		L	Comm
325C6	SD/FF/WS/IWS	26			1.5E+02			83		L	Comm
601C2	DS/FF/WS	126			2.1E+02			41		L	Comm
209C1	WHB/FF/VQ/PT/DM	2	54		2.4E+02			99		L	Comm
325C5	SD/FF/WS/IWS	29			2.5E+02			88		L	Comm
222B3	WHB/SD/CI/ESP/Q/PBS	6			2.5E+02			98	Nor, Carbon injection	L	Comm
209C2	WHB/FF/VQ/PT/DM	2	62		2.5E+02			99		L	Comm
334C1	WS/WESP/PT	10			3.0E+02			97		L	OS

TABLE 7-1. INCINERATOR MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	Size Class	Syst Type
		Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)				
458C2	VS/PT/QT	43			4.5E+02	0.3		90		S	OS
214C1	Q/IWS	482			8.8E+02			45		L	Comm
602C2	Q/S/C/DM/HEPA	3388		0.2	1.2E+03		100	-174		L	OS
354C5	QC/AS/VS/DM/IWS	43			1.6E+03			97		L	OS
354C1	QC/AS/VS/DM/IWS	1	20	4	1.8E+03	0.5		100		L	OS
214C2	Q/IWS	49			2.1E+03			98		L	Comm
222B6	WHB/SD/CI/ESP/Q/PBS	28			2.3E+03			99	Carbon injection	L	Comm
214C3	Q/IWS	32			3.4E+03			99		L	Comm
504C1	VS/C	1333	2	2	3.6E+03	0.1	97	63		L	OS
602C3	Q/S/C/DM/HEPA	3141		0.3	4.2E+03		100	25		L	OS
602C1	Q/S/C/DM/HEPA	5623		0.4	5.3E+03		100	-5		L	OS
327C3	SD/FF/WS/WESP	1178			9.4E+03	2		87		L	Comm
327C2	SD/FF/WS/WESP	409			1.4E+04	9		97		L	Comm
222C1	WHB/SD/ESP/Q/PBS	13759			1.4E+04		100	3		L	Comm
601C4	DS/CI/FF/WS	309			1.5E+04			98	Carbon injection	L	Comm
327C1	SD/FF/WS/WESP	1396			2.2E+04	9		94		L	Comm
480C3	QC/HS	35735			6.3E+04			43		L	OS
601C3	DS/FF/WS	62465			7.6E+04			17		L	Comm
216C7	HES/WS	0.2	67					NA		L	Comm
346C1	C/QC/VS/PT/DM	0.4						NA		L	OS
604C1	HS	0.5	80					NA		S	OS
347C4	C/QT/VS/PBS/DM	1						NA	B, 1 run	S	OS
471C1	QT/FF	1						NA		S	OS
725C1	WS/QT	1	100					NA		S	OS
216C5	HES/WS	1						NA		L	Comm
711C4	C/WHB/VS/AS	1						NA		L	OS
503C1	C/HE/FF	1						NA		S	OS
348C3	QC/AS/IWS	1	100					NA		S	OS
347C2	C/QT/VS/PBS/DM	2	100					NA	B	S	OS
348C2	QC/AS/IWS	2	100					NA		S	OS
347C8	C/QT/VS/PBS/DM	2						NA		S	OS
353C1	QC/VS/DM/WESP	2						NA		L	OS
347C1	C/QT/VS/PBS/DM	3	30					NA		S	OS

TABLE 7-1. INCINERATOR MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	Size Class	Syst Type
		Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)				
605C1	WS	4	100					NA	Nor	S	OS
603C3	QT/S/IWS	4						NA		L	Comm
494C1	C/QT/VS/PBS/DM	5						NA		S	OS
344C3	QC/VS/PT/DM	5	24					NA		S	OS
493C1	C/QT/VS/PBS/DM	6						NA		S	OS
342C1	WHB/QC/S/VS/DM	6						NA		S	OS
353C2	QC/VS/DM/WESP	7						NA		L	OS
470C1	QT/VS/PBS/DM	7	11					NA		S	OS
347C3	C/QT/VS/PBS/DM	16						NA		S	OS
1001C5	HE/FF	20						NA		S	OS
1001C3	HE/FF	20						NA		S	OS
348C4	QC/AS/IWS	25						NA		S	OS
338C1	QC/FF/SS/C/HES/DM	28						NA	Nor	L	OS
609C1	SS/PT/VS/DM	34						NA		L	Comm
331C1	PT/IWS	38						NA		L	Comm
216C6	HES/WS	40	21					NA		L	Comm
503C2	C/HE/FF	45						NA		S	OS
334C3	WHB/Q/WS/WESP/PT/WS	54						NA	Nor	L	OS
325C8	SD/FF/WS/IWS	69						NA	Nor	L	Comm
338C2	QC/FF/SS/C/HES/DM	90						NA		L	OS
1001C4	HE/FF	91						NA		S	OS
806C1	C/VS	173						NA		L	OS
1001C2	HE/FF	177						NA		S	OS
325C3	SD/FF/WS/IWS	179						NA		L	Comm
216C3	HES/WS	261						NA		L	Comm
603B3	QT/S/IWS	842						NA		L	Comm
806C2	C/VS	118						NA		L	OS

Part 2. Facilities no longer burning hazardous waste

330C2	QT/PBS/DM	5	28	0.07	4.2E-02	78	-4240	NLBHW, MB prob	S	Comm
807C3	C/WHB/VQ/PT/HS/DM	5	21		6.0E-01	33	-691	NLBHW, MB prob	L	OS
807C2	C/WHB/VQ/PT/HS/DM	18			1.8E+00		-897	NLBHW, MB prob	L	OS

TABLE 7-1. INCINERATOR MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	Size Class	Syst Type
		Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)				
400C1	SD/FF	10	100	27252	5.0E+00			99.96	NLBHW	L	Comm
807C1	C/WHB/VQ/PT/HS/DM	11			1.4E+01			25	NLBHW	L	OS
902C1	QT/VS/PT	48			3.2E+01			-48	NLBHW	L	OS
500C1	QC/VS/KOV/DM	1	100		5.4E+01	99		97	NLBHW	L	OS
329C1	PT/IWS	108		0.50	3.4E+02	7	91	68	NLBHW	L	Comm
330C1	QT/PBS/DM	2	100	0.04		100		-6096	NLBHW, MB prob	S	Comm

TABLE 7-2. MERCURY CONTROL FROM SELECT WET SCRUBBING SYSTEMS

EPA ID No.	Name/Location	APCS	Hg Contr. Eff. %	Hg MTEC $\mu\text{g/dscm}$	CI MTEC $\mu\text{g/dscm}$
	Savannah River Site CIF	HS/HEPA	0	5000	?
222	WTI, East Liver. OH	WHB/SD/ESP/PBS	8	15000	2.00E+07
601	Laidlaw, Clive UT	WHB/DS/FF/PBS	15	70000	1.30E+07
504	Chevron Chem., Phil. PA	VS	40	2500	6.40E+04
480	Ciba Giegy, St. Gab. LA	HS	40	60000	?
307	Norlite, Cohoes NY	FF/VS	75	2000	1.40E+07
357	Oak Ridge NL TSCA	VS/PBS/IWS	80	10	?
	EPA IRF, Jefferson AK	CCS/WESP	87	300	wide range
327	Aptus, Argonite	SD/FF/WS/WESP	90+	10000	2.00E+07

HS: Hydrosonic wet scrubber

CCS: Calvert collision wet scrubber

PBS: Packed bed wet scrubber

WESP: Wet electrostatic precipitator

TABLE 7-3. CEMENT KILN MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	Cond Date
		Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)			
Part 1. Long non in-line raw mill kilns burning hazardous waste										
204C1	ESP	17		52	2	100		69	Suspect HW MTEC of 130455	7/1/92
319C1	ESP	56		35	2	100		-48		5/5/92
305C3	ESP	5		87	5	0.1		95		8/20/92
208C1	ESP	18		56	6	81	27	71		1/1/93
207C1	MC/ESP	17		58	6	79	100	73		1/1/93
304C1	ESP	42		43	9	92		18	Suspect RM MTEC Nor	8/1/92
205C1	ESP	29		24	10	83		14		8/1/92
203C1	ESP	15		19	11	63		48		8/19/93
206C1	ESP	18		10394	19	100		100		8/1/92
319D9	ESP	24			20			N/A		9/1/96
323C9	ESP	42		2	26	6		-49		6/1/96
404C1	ESP	2	100	10	27	23		94		
305C1	ESP	10		153	30			94		3/1/93
320C3	FF	19		322	30			95		8/1/95
402C4	ESP	53		12	30			-25		4/4/94
401C5	ESP	23		6	47	17		57		3/1/94
302C3	ESP	15		852	51	65		98	Suspect HW MTEC of 25494	8/1/95
403C1	ESP	5	100	9	61	14		93		10/1/92
322C8	ESP	31		1	70			57		11/1/95
403C3	ESP	21		10	82	8		77		11/1/94
404C4	ESP	117		11	87	8		-20		1/17/95
335C1	ESP	62		67	88	0.4		60	Suspect RM MTEC	6/1/92
323B2	ESP	72		2	92	3		24		6/1/96
323B3	ESP	36		2	111			68		11/1/95
402C1	ESP	10	100	5078	117	99		100		3/27/92
491C1	ESP	26		682	360	77		98		8/18/95
473C1	ESP	17			456			96	Pre-BIF testing	5/8/95
401C1	ESP	145		6	544	2		74		4/9/92
228C6	ESP	0.2						N/A		10/1/88
228C7	ESP	0.5						N/A		10/1/88
208C3	ESP	2						N/A		1/1/97

TABLE 7-3. CEMENT KILN MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	Cond Date
		Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)			
207C3	MC/ESP	3						N/A		1/1/97
201C1	FF	6						N/A		8/21/92
204B2	ESP	7						N/A		9/13/96
200C1	FF	8						N/A	2 runs	8/21/92
205C5	ESP	10						N/A		9/15/95
203C5	ESP	10						N/A		8/16/96
319D6	ESP	12						N/A		9/1/96
204B3	ESP	12						N/A		9/13/96
323B1	ESP	18		7		26		-159	B, 2 runs	6/1/96
335C6	ESP	20						N/A	Nor	7/8/93
206C5	ESP	21						N/A		9/15/95
320C5	FF	22						N/A	Nor	1/17/95
205C7	ESP	23						N/A	Nor	6/20/95
680C1	FF	27						N/A	Metals spiked, not in report	11/11/93
203C2	ESP	34						N/A		5/24/94
472C2	ESP	54						N/A	1 run	5/1/91
472C1	ESP	68						N/A	2 runs	5/1/91
681C1	FF	98						N/A	Metals spiked, not in report	11/10/93
305B3	ESP	106						N/A	Nor	10/17/96
335B2	ESP	192						N/A	Nor	10/7/96
201C2	FF	965						N/A		1/30/91
681C2	FF	1238						N/A		6/5/91

Part 2. Short and/or in-line raw mill kilns

202C2	FF	20		25	5	95	31	ILRM (off)		10/1/92
202C5	FF	10		8		100	-17	ILRM (off)		12/1/96
303C1	QC/FF	4		231			98	Short, B, Nor, ILRM (on)		1/1/93
303C3	QC/FF	92		324	52		76	Short, ILRM (off), CMBM		1/1/93
303C6	QC/FF	52					N/A	Short, ILRM (on), B, CMBM		9/1/92
303C7	QC/FF	299		1211	27		76	Short, ILRM (off), CMBM		12/1/95
303C9	QC/FF	43		1117	9		96	Short, ILRM (on), Nor, CMBM		12/1/95

TABLE 7-3. CEMENT KILN MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	Cond Date
		Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)			
321C3	ESP	12						N/A	Short, ILRM (off), B, BPM	10/13/93
321C3	ESP	18						N/A	Short, ILRM (off), B, 2 runs	10/13/93
321C4	ESP	28						N/A	Short, ILRM (on), Nor, 2 runs	10/13/93
321C4	ESP	116						N/A	Short, ILRM (on), Nor, 2 runs, BPM	10/13/93
321C5	ESP	19		476	28			96	Short, ILRM (on), BPM	8/1/95
321C5	ESP	105		476	28			79	Short, ILRM (on)	8/1/95

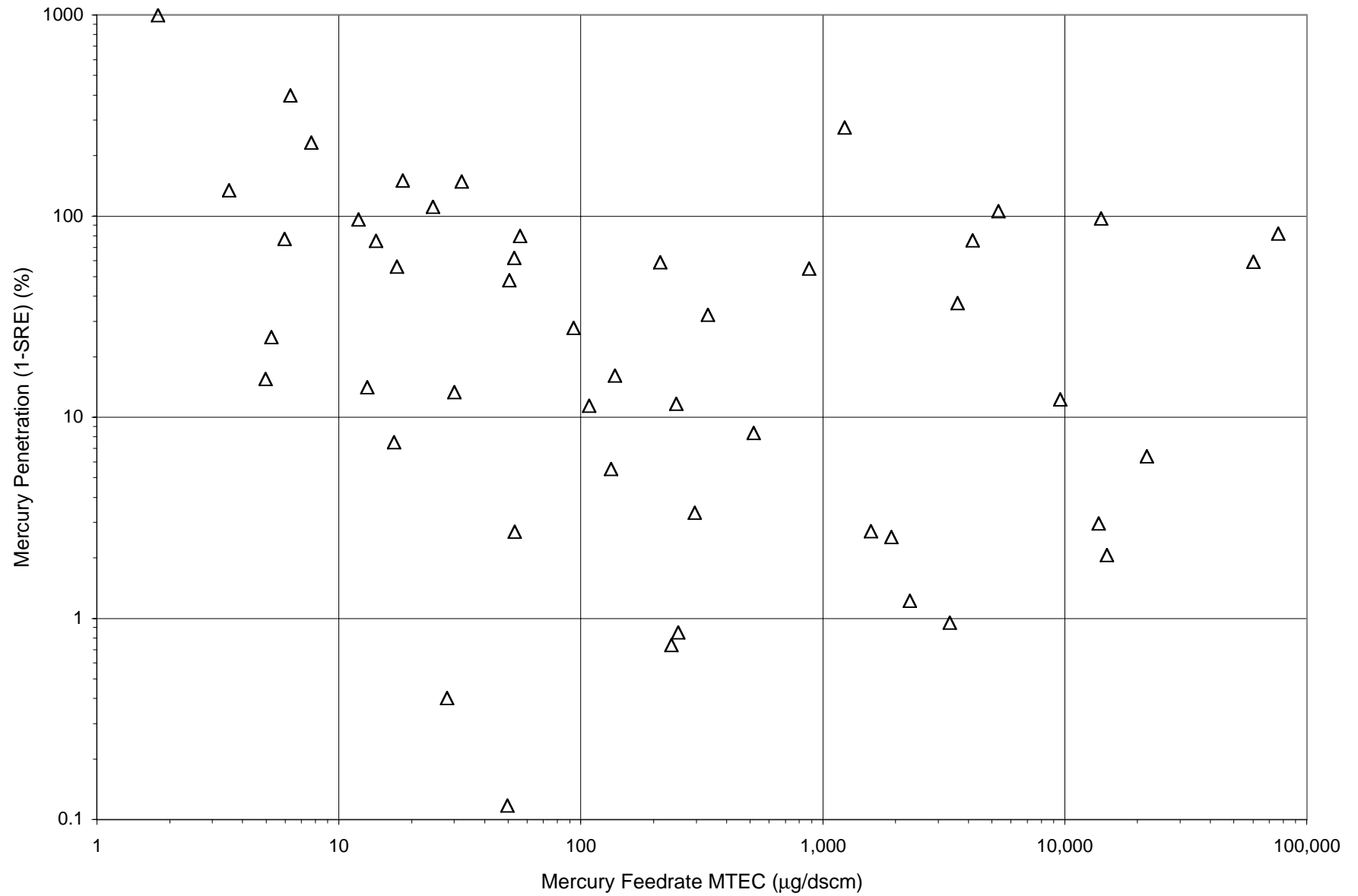
Part 3. Kilns no longer burning hazardous waste

406C4	ESP	25		19	20			37	Short, NLBHW, CMBM	8/1/95
309C6	MC/ESP	27		10	27	43		28	NLBHW	7/1/96
406B4	ESP	4	100	10	58	25		94	Short, NLBHW	8/1/92
309C1	MC/ESP	45		63	87			70	NLBHW	10/1/92
405C1	ESP	10	100	8	150	14		93	Short, NLBHW, CMBM	8/1/92
301C2	FF	26		228	236	62		94	Short, NLBHW, ILRM (off), BPM	5/1/93
301C2	FF	83		228	236	62		82	Short, NLBHW, ILRM (off)	5/1/93
301C2	FF	130		228	236	62		72	Short, NLBHW, ILRM (off)	5/1/93
306C1	MC/FF	3022		494	3188	0.1		18	NLBHW, Mercury spiked	5/1/93
405C4	ESP	3						N/A	Short, NLBHW, B	8/1/95
315C6	FF	6						N/A	Short, ILRM (off), NLBHW, B	4/16/91
315C6	FF	10						N/A	Short, ILRM (off), NLBHW, B, BPM	4/16/91
315C4	FF	13						N/A	Short, ILRM (on), NLBHW	4/16/91
315C5	FF	17						N/A	Short, ILRM (on), NLBHW	4/16/91
469C1	ESP	19						N/A	Nor, NLBHW, Pre-BIF	1/31/90
315C5	FF	33						N/A	Short, ILRM (on), NLBHW, BPM	4/16/91
405C6	ESP	34						N/A	Short, NLBHW, 1 run, Pre-BIF, CMBM	12/17/90
315C4	FF	35						N/A	Short, ILRM (on), NLBHW, BPM	4/16/91
405C5	ESP	55						N/A	Short, NLBHW, Pre-BIF, 2 runs, CMBM	12/17/90

TABLE 7-4. LWAK MERCURY

EPA Cond ID	APCS	Hg Emiss		Hg MTECs (µg/dscm)				SRE (%)	Summary Comments	No. Runs	Cond Date
		Actual Stack (µg/dscm)	ND (%)	Other	HW	ND (%)	S/HW (%)				
Part 1. Kilns burning hazardous waste											
226C2	FF	3	100		0				NW, NS	3	8/26/97
314C3	FF	3	66		0				NW, NS	3	3/18/96
608C1	FF	6		15	2	100		67	NW, NS	3	3/1/96
475C1	FF	33		11	4	100		-117	NW, NS	3	6/23/93
225C2	FF	5		7	5			62	NW, NS	3	8/1/96
310C2	FF	8	65	8	6	100		42	NW, NS	3	8/16/95
226C1	FF	17		75	7			79	NW, NS	3	7/1/93
225C1	FF	5		13	7	80		78	NW, NS	3	8/1/93
336C3	FF	12			7			-65	NW, NS	3	5/1/95
474C1	FF	8		36	7			81	NW, NS	3	9/1/94
224C1	FF	16		9	9	73		13	NW, NS	3	8/1/93
310C1	FF	15		14	9	75		32	NW, NS	3	8/12/92
476C1	FF	47		10	10			-140	NW, NS	3	2/1/93
224C2	FF	6	42		11			45	NW, NS	3	8/1/96
312C1	FF	4	100	15	12	72		84	NW, NS	3	8/8/92
312C2	FF	4			12			63	NW, NS	3	5/1/95
223C1	FF	32		29	17			31	NW, NS	3	8/1/93
313C1	FF	0.2	100	28	17	19		100	NW, NS	3	8/8/92
311C1	FF	8	100	17	24	58		82	NW, NS	3	8/8/92
314C1	FF	22		47	64	10		80	NW, NS	3	8/8/92
307C3	FF/VS	469		75	2027		99	78	Hg S	4	12/1/92
307C2	FF/VS	561		76	2181		99	75	Hg S	4	12/1/92
307C4	FF/VS	493		86	2273		99	79	Hg S	3	12/1/92
307C1	FF/VS	421		93	2369		99	83	Hg S	4	12/1/92
Part 2. Kilns no longer burning hazardous waste											
227C1	FF	17		27	5	100		47	NLBHW, NW, NS	3	1/1/94

Sheet4 Chart 1



CHAPTER 8

SEMIVOLATILE METALS

The semivolatile metals (SVM) group includes cadmium and lead. This grouping is based on similar behavior and control of lead and cadmium in the combustor system.

SVM are controlled by limiting SVM feedrate in the hazardous waste and through efficient PM control. SVM are directly controlled through feedrate. As discussed in Chapter 12, there is a direct relationship between SVM stack gas emissions and feedrates.

SVM are generally volatile at typical combustion temperatures. They are not generally contained in the “bottom ash” or clinker. SVM usually condense onto the fine particulate at the PM APCD temperatures where they are collected. Thus, the control of SVM emissions is related in part to PM control. Additionally, because these metals typically condense onto the fine PM that is less effectively collected than large particulate, the control efficiency for SVM is generally lower than that for total PM.

It is speculated that, in cement kilns and lightweight aggregate kilns, certain raw material constituents such as sand and clays may act to bind up the SVMs in the clinker or aggregate product, providing additional control.

For the proposed rule, the MACT floor was set by: (1) defining MACT control based on SVM feed rate and APCS used by the best performing (lowest emitting) 6% of sources; and (2) determining the MACT floor standard as the highest test condition average of all sources using MACT controls. Many commenters to the proposed rule stated that this analysis procedure: (1) was inconsistent because different APCS MACT control definitions for SVM, LVM, and PM can result, although these three constituents are all controlled similarly through good PM control; and (2) produced unreasonably low MACT waste feedrate limits based on best performing sources that did not (for whatever reason) feed wastes containing metals.

For the MACT 1997 NODA reanalysis, the evaluation procedure involved:

- Identifying all SVM emissions data with corresponding PM test condition data at or below the PM MACT floor level.
- Determining a SVM MACT floor standard that is reasonably achievable based on the SVM emissions data identified in the previous step. This involves screening the data set by a breakpoint emissions evaluation to remove “outlier” conditions that may be a result of non-typical feed rates, measurement inaccuracies, high detection limits, etc.

Due to a variety of concerns with the May 1997 NODA approach, the final rule approach uses the “Aggregate Feedrate” analysis procedure to define a MACT hazardous waste feedrate MTEC. This is discussed in Chapter 2, with results presented in Chapter 6. The SVM standard is then based on facilities using MACT control, involving meeting the MACT hazardous waste feedrate MTEC limit and using MACT floor PM control.

8.1 INCINERATORS

Table 8-1 summarizes all SVM test condition data from HWIs. The table is divided into four sections. The first part contains all test conditions from incinerators that are using MACT PM floor control (FF, IWS, or ESP and meeting the floor level of 0.015 gr/dscf) and are burning hazardous waste. The conditions are ranked by hazardous waste MTEC. The second part contains test conditions from facilities that are using the MACT PM floor control technology (FF,ESP, or IWS) but are not meeting the PM floor level of 0.015 gr/dscf. The third part contains conditions from facilities that are not using MACT PM floor control in any part and are burning hazardous waste. The last part contains test conditions from incinerators that are no longer burning hazardous wastes.

The data are from over 40 different HWIs. Condition averages range widely from 1 to almost 30,000 µg/dscm.

8.1.1 Existing Source Floor

MACT floor control is based on the use of feedrate control of SVM in hazardous waste, as well as use of MACT floor PM control. PM MACT floor control, discussed in Chapter 4, involves the use of FF, ESP, or IWS, and achieving the PM floor level of 0.015 gr/dscf.

As identified in Chapter 6 from the Aggregate Feedrate approach, the SVM MACT defining feedrate hazardous waste MTEC is 5.3×10^3 $\mu\text{g}/\text{dscm}$. Note that:

- SVM feedrate hazardous waste MTECs from sources using the MACT PM control range from 100 to 1.5×10^6 $\mu\text{g}/\text{dscm}$. About 30% of the hazardous waste MTECs from sources meeting the MACT PM level are less than this MACT hazardous waste MTEC level.
- SVM feedrate hazardous waste MTECs from all incinerators range from 1 to 1.5×10^6 $\mu\text{g}/\text{dscm}$. Over 40% of the MTECs from the entire incinerator universe are less than the MACT MTEC level.

The resulting MACT floor is 240 $\mu\text{g}/\text{dscm}$. This corresponds to the highest test condition average, from Source ID No. 325C5, using MACT of both PM less than 0.015 gr/dscf (and FF, ESP, or IWS) and an SVM MTEC of less than the MACT MTEC of 5.3×10^3 $\mu\text{g}/\text{dscm}$. Note that:

- SVM emissions from incinerators meeting the PM MACT floor (29 different test conditions) range from 1 to 6,000 $\mu\text{g}/\text{dscm}$. Only 1 of the 29 test conditions is higher than the MACT floor level of 240 $\mu\text{g}/\text{dscm}$ (i.e., only 1 was screened out due to feedrates higher than the MACT defining level).
- Over 60% of all incinerator SVM condition emissions are less than the MACT floor level of 240 $\mu\text{g}/\text{dscm}$.

8.1.2 New Source Floor

MACT for new sources includes the use of MACT floor PM control (identical to that for existing sources) and feedrate control of SVM in the hazardous waste. As identified in Chapter 6 from the MACT Aggregate Feedrate approach, the SVM MACT defining feedrate MTEC is 3.5×10^3 $\mu\text{g}/\text{dscm}$. The resulting MACT floor is 24 $\mu\text{g}/\text{dscm}$, based on source ID No. 341C1.

8.2 CEMENT KILNS

Table 8-2 summarizes all SVM test condition data from CKs, ranked by PM test condition average. The table is divided into four parts. The first part contains test conditions from long and non in-line raw mill kilns meeting the MACT PM floor and currently burning hazardous waste. Conditions are ranked by hazardous waste feedrate MTEC. The second part contains test conditions from long and non in-line raw mill kilns that are not meeting the PM floor. The third

part contains test conditions from short and in-line raw mill kilns. The last part contains test conditions from kilns no longer burning hazardous waste.

The data are from about 35 different CKs. Condition averages range from 4 to 6,000 $\mu\text{g}/\text{dscm}$. SVM system removal efficiencies (SRE) in cement kilns typically range from 99 to 99.9%, with some greater than 99.99%. This depends on factors such as feed rate MTEC level, APCD type, and other system operating characteristics such as kiln dust recycling rates.

8.2.1 Existing Source Floor

MACT control for SVM includes control of SVM in the hazardous waste, and meeting the MACT PM floor. As discussed in Chapter 4, PM floor control involves meeting 0.03 gr/dscf (the equivalent to the NSPS). As identified in Chapter 6 from the MACT Aggregate Feedrate approach, the CK SVM MACT defining hazardous waste feedrate MTEC is $8.1 \times 10^4 \mu\text{g}/\text{dscm}$. About 40% of CK SVM hazardous waste MTECs are less than this level (CK SVM MTECs range from 10,000 to 450,000 $\mu\text{g}/\text{dscm}$).

The resulting CK SVM MACT floor is 650 $\mu\text{g}/\text{dscm}$. All but two of the CK SVM emissions which are meeting the PM MACT floor are less than this level (two conditions at 1,000 and 1,200 $\mu\text{g}/\text{dscm}$). This represents over 80% of all CK SVM emissions.

Short kilns and those with in-line raw mills can meet the SVM floor level. Specifically:

- Source ID No. 303 (short kiln with a combined bypass and main stack and in-line raw mill) has SVM levels from five test conditions, ranging from 2 to 32 $\mu\text{g}/\text{dscm}$.
- Source ID No. 321 (short kiln with separate bypass and main stacks and in-line raw mill) has recent CoC testing with SVM levels in the individual stacks both less than 11 $\mu\text{g}/\text{dscm}$. In older CoC testing, the SVM in the bypass stack was 306 $\mu\text{g}/\text{dscm}$, with main stack SVM of 11 $\mu\text{g}/\text{dscm}$.
- Source ID No. 202 (long kiln with in-line raw mill) has SVM emissions data from two test conditions at levels of 110 and 230 $\mu\text{g}/\text{dscm}$.

For short kilns with alkali bypass stacks, the majority of the SVM concentrates in the bypass CKD due to an internal recycle wherein metals vaporize at kiln temperature and condense in the preheater towers. Main stack CKD has also been shown to be enriched with SVM, but to a

much lower degree than that of the bypass. Thus, bypass concentrations are higher than those in the main stack, as clearly demonstrated in the testing at Source ID No. 303. The internal recycle build-up is dependent on the bypass gas removal fraction and the constituent volatility. For high volatile metals such as mercury, discussed in Chapter 7, which generally do not tend to condense at APCD operating temperatures, no internal recycle is created. Similarly, an internal recycle is avoided for low volatile metals because they are largely released from the system through the clinker.

For in-line raw mill kilns, SVM emissions are generally lower during the in-line raw mill operation, as might be expected due to additional scavenging of SVM vapors in the low temperature raw mill.

Note that the cement kiln SVM (and LVM) floor is evaluated and presented using PM gas concentrations (i.e., gr/dscf). This is not consistent with the cement kiln PM MACT floor, which as discussed in Chapter 4, is expressed in an emissions factor format (as the Portland Cement NSPS of 0.3 lb PM per dry ton of raw material processed). The PM floor gas concentration equivalent for wet process kilns of 0.03 gr/dscf is used as an estimate for the MACT floor emissions factor of 0.3 lb/ton raw material. The use of PM gas concentrations for the floor evaluation is due to the availability of more and higher quality PM emissions concentration data (gr/dscf) compared with NSPS-based emissions factor data. In any case, the MACT floors have also been investigated using the PM data in the emissions factor format (lb/ton dry raw materials). The Aggregate Feedrate results (MACT control feedrate levels), as well as the LVM and SVM cement kiln MACT floors, are identical to those using the above evaluation based on PM gas concentrations and an equivalent MACT floor of 0.03 gr/dscf.

8.2.2 New Source Floor

MACT for new sources includes the use of MACT floor PM control (identical to that for existing sources) and feedrate control of SVM in the hazardous waste. As identified in Chapter 6 from the MACT Aggregate Feedrate approach, the CK SVM MACT defining hazardous waste feedrate MTEC is $3.5 \times 10^4 \mu\text{g/dscm}$. The resulting CK SVM MACT floor is $180 \mu\text{g/dscm}$.

8.3 LIGHTWEIGHT AGGREGATE KILNS

Table 8-3 summarizes all SVM test condition data from LWAKs. The table is divided into two sections. The first section contains test conditions from kilns currently burning hazardous

waste and using MACT floor PM control. Note that all LWAK test conditions meet the MACT PM floor. The second set contains the single facility that is no longer burning hazardous waste.

The data are from 22 conditions from 15 different LWAKs. Condition averages range widely from 1 to over 1,600 $\mu\text{g}/\text{dscm}$. SVM SREs in LWAKs range from 99 to 99.9%, with some as high as 99.99%.

8.3.1 Existing Source Floor

MACT floor control involves the use of SVM control in the hazardous waste and MACT PM floor control. As discussed in Chapter 4, the MACT PM floor level is 0.025 gr/dscf . As identified in Chapter 6 from the MACT Aggregate Feedrate approach, the SVM MACT defining feedrate MTEC is $2.0 \times 10^6 \mu\text{g}/\text{dscm}$. Note that the MACT defining MTEC is the highest in the entire LWAK dataset. LWAK SVM hazardous waste MTECs range from 50,000 to $2 \times 10^6 \mu\text{g}/\text{dscm}$.

The resulting MACT floor is 1,700 $\mu\text{g}/\text{dscm}$, which corresponds to the highest LWAK SVM test condition average.

8.3.2 New Source Floor

MACT floor control for new sources also includes the use of floor PM control (identical to that for existing sources) and SVM hazardous waste feedrate control. As identified in Chapter 6 from the MACT Aggregate Feedrate approach, the SVM MACT defining feedrate MTEC is $3.3 \times 10^5 \mu\text{g}/\text{dscm}$. The resulting MACT floor is 43 $\mu\text{g}/\text{dscm}$.

TABLE 8-1. INCINERATOR SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
Part 1. MACT PM floor control									
348C4	QC/AS/IWS	0.0003	2			3.5E+01	64	4/16/95	OS
341C1	DA/DI/FF/HEPA/CA	0.003	24	64		2.5E+02	100	10/1/93	OS
341C2	DA/DI/FF/HEPA/CA	0.001	14	100		2.3E+02	100	10/1/93	OS
348C3	QC/AS/IWS	0.0002	2		4.4E+00	8.1E+02	8	4/16/95	OS
348C1	QC/AS/IWS	0.002	3		3.1E+00	9.2E+02	0	2/10/94	OS, Cd only
603C8	QT/S/IWS	0.002	3	18	7.0E+00	3.5E+03	0	5/20/90	Comm
340C2	WHB/ESP/WS	0.005	13			3.7E+03	6	9/1/92	WHB, OS
601C1	WHB/DS/FF/WS	0.005	36			4.1E+03		5/1/96	WHB, Comm
325C4	SD/FF/WS/IWS	0.004	91			4.7E+03		12/1/90	Comm
325C5	SD/FF/WS/IWS	0.004	235			5.3E+03		12/1/90	Comm
340C1	WHB/ESP/WS	0.008	5	28		5.7E+03	4	9/1/92	WHB, OS
325C6	SD/FF/WS/IWS	0.002	218			6.2E+03		12/1/90	Comm
601C2	WHB/DS/FF/WS	0.011	92			8.1E+03		5/1/96	WHB, Comm
325C7	SD/FF/WS/IWS	0.005	56			9.0E+03		12/1/90	Comm
348C2	QC/AS/IWS	0.0003	4		4.1E+00	2.0E+04	0	4/16/95	OS
354C1	QC/AS/VS/DM/IWS	0.001	2	54	2.5E+01	2.6E+04	0	4/1/92	OS
337C1	WHB/DA/DI/FF	0.0003	62	57		4.2E+04		2/28/92	WHB, OS
602C2	Q/S/C/DM/HEPA	0.002	8		2.1E+01	5.1E+04	0	7/15/97	OS
602C1	Q/S/C/DM/HEPA	0.002	25		6.2E+01	5.4E+04	0	7/15/97	OS
602C3	Q/S/C/DM/HEPA	0.002	10		5.9E+01	6.7E+04	0	7/15/97	OS
209C1	WHB/FF/VQ/PT/DM	0.001	11			1.3E+05		6/20/91	WHB, Comm
222B3	WHB/SD/CI/ESP/Q/PBS	0.003	7			1.5E+05		9/12/95	Nor, WHB, Comm
209C2	WHB/FF/VQ/PT/DM	0.001	7			1.7E+05		6/20/91	WHB, Comm
327C2	SD/FF/WS/WESP	0.002	22	18		2.1E+05	1	8/1/92	Comm
327C3	SD/FF/WS/WESP	0.001	38			3.2E+05	5	8/1/92	Comm
349C3	QC/FF/QC/PT	0.001	35			5.3E+05		6/1/93	OS, Pb only
222C1	WHB/SD/CI/ESP/Q/PBS	0.003	83			7.9E+05		5/1/93	WHB, Comm
331C3	Q/PT/IWS/DM	0.015	6822			8.5E+05		5/1/92	Comm, Pb only
327C1	SD/FF/WS/WESP	0.001	25			9.3E+05	8	8/1/92	Comm
601C3	WHB/DS/FF/WS	0.003	41			1.5E+06		5/1/96	WHB, Comm
222C5	WHB/SD/CI/ESP/Q/PBS	0.001	2					2/1/94	Nor, WHB, Comm, Pb only

TABLE 8-1. INCINERATOR SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
325C8	SD/FF/WS/IWS	0.0004	4	39				10/6/94	Nor, Comm
222B1	WHB/SD/CI/ESP/Q/PBS	0.002	5					1/1/95	Nor, WHB, Comm, Pb only
222B2	WHB/SD/CI/ESP/Q/PBS	0.003	5					3/1/95	Nor, WHB, Comm, Pb only
353C1	QC/VS/DM/WESP	0.008	6	85				7/1/89	OS
222C9	WHB/SD/CI/ESP/Q/PBS	0.004	9					9/1/94	Nor, WHB, Comm, Pb only
338C1	QC/FF/SS/C/HES/DM	0.001	14	100				8/1/90	Nor, OS
338C2	QC/FF/SS/C/HES/DM	0.001	16	100				8/1/90	OS
471C1	QT/FF	0.003	28	3				3/1/95	OS
222C8	WHB/SD/CI/ESP/Q/PBS	0.002	35					6/1/94	Nor, WHB, Comm, Pb only
603B3	QT/S/IWS	0.002	45					10/19/94	Comm
603C3	QT/S/IWS	0.006	47					9/21/92	Comm
349C4	QC/FF/QC/PT	0.001	55					6/1/93	B, Nor, OS, Pb only
600C3	WHB/QC/PT/IWS	0.003	166					12/14/95	WHB, OS
353C2	QC/VS/DM/WESP	0.011	210					7/1/89	OS
359C4	WHB/FF/S	0.003	226	1				6/1/90	WHB, Comm
359C5	WHB/FF/S	0.009	332					6/1/90	WHB, Comm
331C1	Q/PT/IWS/DM	0.008	3416					3/1/93	Comm
1001C5	C/HE/FF	0.013	7420					12/6/93	OS
1001C3	C/HE/FF	0.009	7670					12/6/93	OS
1001C2	C/HE/FF	0.010	7760					12/6/93	OS

Part 2. MACT PM control (FF, IWS or ESP) but not meeting PM floor

705C1	QT/VS/PT/WESP	0.073	198			4.3E-01	7	3/22/90	OS
705C2	QT/VS/PT/WESP	0.052	404			2.1E+02		3/22/90	OS
334C2	WHB/Q/WS/WESP/PT/WS	0.058	1704			5.1E+02	19	9/6/90	WHB, OS
503C3	C/HE/FF	0.016	994			6.3E+03		5/30/91	OS
503C2	C/HE/FF	0.029	966			7.2E+04		3/1/93	OS
354C5	QC/AS/VS/DM/IWS		183			7.6E+04		9/1/92	OS
334C1	WHB/Q/WS/WESP/PT/WS	0.062	7990			1.2E+05		9/6/90	WHB, OS
214C2	Q/IWS	0.028	689			2.2E+05		5/3/88	Comm
503C1	C/HE/FF	0.028	794			3.3E+05		3/1/93	OS
214C3	Q/IWS	0.019	1000			3.4E+05		5/3/88	Comm

TABLE 8-1. INCINERATOR SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
503C4	C/HE/FF	0.019	600			4.0E+05		5/30/91	OS
331C2	Q/PT/IWS/DM	0.024	20617			1.2E+06		5/1/92	Comm
325C3	SD/FF/WS/IWS		2					12/1/91	Comm
214C1	Q/IWS	0.017	197	3				4/28/87	Comm
359C6	WHB/FF/S	0.077	986	1				6/1/90	WHB, Comm
334C3	WHB/Q/WS/WESP/PT/WS	0.048	4554					3/11/88	Nor, WHB, OS
1001C4	C/HE/FF	0.020	12370					12/6/93	OS

Part 3. Not using MACT PM floor control

712C1	WHB	0.038	0.4	25		1.6E-01	29	2/1/93	WHB, OS, Cd only
229C6	WHB/ACS/HCS/CS	0.026	3	100		4.8E-01		2/12/91	WHB, OS, Cd only
229C3	WHB/ACS/HCS/CS	0.017	2	100		6.1E-01		2/12/91	WHB, OS, Cd only
712C2	WHB	0.023	0.4	57		6.6E-01	42	10/1/92	WHB, OS, Cd only
229C5	WHB/ACS/HCS/CS	0.031	3	100		8.7E-01		2/12/91	WHB, OS, Cd only
229C1	WHB/ACS/HCS/CS	0.010	2	100		4.5E+01	100	4/16/91	WHB, OS, Cd only
229C2	WHB/ACS/HCS/CS	0.012	2	100		5.9E+01	100	4/16/91	WHB, OS, Cd only
221C1	SS/PT/VS	0.014	103			1.4E+02	28	8/1/88	Comm
324C3	WHB	0.014	8262			2.2E+02		2/1/89	WHB, Comm
824C1	QT/VS/PT/DM	0.006	43			3.6E+02	4	10/1/89	OS
221C4	SS/PT/VS	0.015	43			3.6E+02	36	8/1/88	Comm
488C2	SS/PT/VS/DM	0.010	810			6.3E+02	89	9/1/89	Comm
488C3	SS/PT/VS/DM	0.008	616			1.1E+03	87	9/1/89	Comm
221C5	SS/PT/VS	0.013	29			1.3E+03	4	8/1/88	Comm
488C1	SS/PT/VS/DM	0.013	1050			1.4E+03	61	9/1/89	Comm
490C1	SS/PBS	0.011	34			1.5E+03	7	6/1/94	OS
221C3	SS/PT/VS	0.013	23			2.1E+03	2	8/1/88	Comm
324C2	WHB	0.023	3040			3.3E+03		2/1/89	WHB, Comm
324C1	WHB	0.018	537			3.8E+03		2/1/89	WHB, Comm
221C2	SS/PT/VS	0.015	13	4		4.6E+03	3	8/1/88	Comm
706C4	QT/HS/C/DM		1384			9.0E+03		4/1/94	OS, Cd only
324C4	WHB	0.029	838			1.3E+04		2/1/89	WHB, Comm
905C1	QT/VS/AS/CS		1679			1.3E+04	1	2/20/90	OS, Cd only

TABLE 8-1. INCINERATOR SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
489C1	SS/PT/VS/DM	0.013	252			1.6E+04	1	10/1/89	Comm
809C1	WHB/Q/VS		865			2.1E+04		8/30/91	OS
504C1	VS/C	0.021	43	14	1.3E+01	2.5E+04	0	10/11/91	OS
458C2	VS/PT/QT	0.018	1325			2.6E+04		10/1/90	OS
810C1	WHB/Q/VS/PBS		912			5.8E+04		8/30/91	OS
480C3	QC/HS	0.029	15765			1.9E+05		5/31/94	OS
809C2	WHB/Q/VS		20638			2.2E+05		8/30/91	OS
700C1	SD/RJS/VS/WS	0.057	29483		5.0E+00	2.2E+05		11/1/92	OS
810C2	WHB/Q/VS/PBS		1777			6.6E+05		8/30/91	OS
347C4	C/QT/VS/PBS/DM	0.001	3	75				4/1/92	B, Nor, OS
494C1	C/QT/VS/PBS/DM	0.009	4					8/15/97	OS
604C1	HS		4	9				3/1/96	OS
711C4	C/WHB/VS/AS	0.024	10					4/1/97	WHB, OS
347C1	C/QT/VS/PBS/DM	0.012	11	15				10/1/93	OS
347C3	C/QT/VS/PBS/DM	0.011	13	6				4/1/92	OS
347C2	C/QT/VS/PBS/DM	0.003	14					10/1/93	B, Nor, OS
344C2	QC/VS/PT/DM	0.002	18					6/17/91	OS, Pb only
342C1	WHB/QC/S/VS/DM	0.004	21					3/16/92	WHB, OS
470C1	QT/VS/PBS/DM	0.002	22	9				12/16/92	OS, Pb only
344C3	QC/VS/PT/DM	0.001	27	12				2/1/93	OS, Pb only
725C1	WS/QT	0.022	35	13				6/19/90	OS
605C1	WS	0.008	51	95				12/8/93	Nor, OS
493C1	C/QT/VS/PBS/DM	0.002	88					7/7/97	OS
346C1	C/QC/VS/PT/DM	0.001	89					6/23/92	OS
216C3	HES/WS		102					12/1/86	Comm
806C2	C/VS	0.031	461					6/1/89	OS
806C1	C/VS	0.056	592					6/1/89	OS
216C7	HES/WS	0.021	824					2/1/90	Comm
216C5	HES/WS	0.033	1021					8/1/88	Comm
216C6	HES/WS	0.027	1045					8/1/88	Comm
347C8	C/QT/VS/PBS/DM	0.004	1090					4/9/97	OS
609C1	SS/PT/VS/DM	0.013	1142					4/1/95	Comm
915C1	QC/VS/C	0.076	1273					9/1/92	OS

TABLE 8-1. INCINERATOR SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		

Part 4. No longer burning hazardous waste

330C2	QT/PBS/DM	0.059	244		2.4E+02	1.2E+02		4/1/91	NLBHW, Comm
500C1	QC/VS/KOV/DM	0.002	4			1.4E+02	39	7/18/88	NLBHW, OS
902C1	QT/VS/PT	0.021	24	2		2.4E+02		12/1/93	NLBHW, OS
356C2	QC/AS/FN/PBS/DM		60			4.5E+02		10/21/90	NLBHW, OS, Cd only
502C1	WHB/QC/PBC/VS/ES	0.036	83	100		8.4E+03	7	7/1/90	NLBHW, WHB, OS, Cd only
807C3	C/WHB/VQ/PT/HS/DM	0.028	56			4.1E+04	29	7/18/91	NLBHW, WHB, OS
400C1	SD/FF	0.006	638	6	2.5E+06	4.2E+04		7/1/91	NLBHW, Comm
329C1	PT/IWS	0.031	2330		1.7E+00	4.9E+04	0	3/27/92	NLBHW, Comm
807C1	C/WHB/VQ/PT/HS/DM	0.034	262			1.7E+05	4	7/18/91	NLBHW, WHB, OS
807C2	C/WHB/VQ/PT/HS/DM	0.022	312			2.2E+05	5	7/18/91	NLBHW, WHB, OS
710C5	QT/OS/C/S	0.025	5573			5.4E+05	0	9/9/93	NLBHW, OS
330C1	QT/PBS/DM	0.023	418		1.1E+02			4/1/91	NLBHW, Comm
332C3	HES	0.063	2174					4/6/87	NLBHW, Comm

TABLE 8-2. CEMENT KILN SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
Part 1. Long non ILRM kilns using MACT PM floor control										
208C2	ESP	0.016	88		5.7E+03	1.6E+04	89	11	1/1/93	
323B2	ESP	0.020	178		3.6E+03	1.8E+04		0.1	6/1/96	
323C9	ESP	0.005	38		1.5E+04	2.0E+04			6/1/96	
200C1	FF	0.013	42	9	2.3E+03	2.6E+04	91	18	8/21/92	
320C1	FF	0.003	4		2.1E+03	3.3E+04	88	0.4	8/1/92	
208C1	ESP	0.014	98		4.5E+03	3.5E+04	88	1	1/1/93	
207C2	MC/ESP	0.018	258		4.9E+03	4.9E+04	91	1	1/1/93	
404C1	ESP	0.007	29	100	1.2E+03	6.2E+04	73	3	11/1/92	
320C3	FF	0.002	6		2.7E+03	6.6E+04	90		8/1/95	
203C5	ESP	0.009	1	96	6.9E+02	7.4E+04	76		8/16/96	
335C1	ESP	0.023	648	29	5.0E+03	7.5E+04	73		6/1/92	
207C1	MC/ESP	0.028	507		7.9E+03	8.1E+04	94	0.4	1/1/93	
204B3	ESP	0.012	363		1.0E+03	1.1E+05	87	0.1	9/13/96	
228C2	ESP	0.013	314	0.4	2.4E+04	1.2E+05	93		5/1/92	
323B3	ESP	0.026	458		8.1E+03	1.2E+05	80		11/1/95	
322C8	ESP	0.013	354		2.4E+03	1.3E+05	88		11/1/95	
403C1	ESP	0.029	501	100	8.8E+02	1.3E+05		1	10/1/92	
205C5	ESP	0.002	76		3.8E+03	1.3E+05	92		9/15/95	
322C1	ESP	0.019	149		2.8E+03	1.4E+05	91	0.1	8/1/92	
323C1	ESP	0.022	1032		5.4E+03	1.4E+05	88	0.2	8/1/92	
206C5	ESP	0.029	515		3.9E+03	1.4E+05	91		9/15/95	
203C1	ESP	0.014	546		3.7E+03	1.6E+05	85		8/19/93	
403C3	ESP	0.029	1234		8.4E+02	1.6E+05	92		11/1/94	
206C1	ESP	0.023	276		5.4E+03	1.6E+05	92	0.3	8/1/92	
404C4	ESP	0.004	81		2.3E+03	1.7E+05			1/17/95	
201C1	FF	0.011	74	79	2.4E+03	1.8E+05		4	8/21/92	
200C4	FF	0.004	21		3.8E+03	2.1E+05			8/1/95	
200C5	FF	0.002	15		2.2E+03	3.2E+05			8/1/95	
320C5	FF	0.014	1	82					1/17/95	Nor
207C3	MC/ESP	0.007	18						1/1/97	
208C3	ESP	0.017	25						1/1/97	

TABLE 8-2. CEMENT KILN SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
204B2	ESP	0.008	34						9/13/96	Nor
323B1	ESP	0.012	44		2.1E+04			0.1	6/1/96	B
203C2	ESP	0.018	61						5/24/94	
203C4	ESP	0.016	69						12/1/93	
319D2	ESP	0.009	78						2/16/95	
300C6	ESP	0.023	88						5/1/87	B, Nor
681C2	FF	0.015	95						6/5/91	
305B3	ESP	0.008	101						10/7/96	Nor
201C2	FF	0.024	170						1/30/91	
228C6	ESP	0.026	181						10/1/88	
319D1	ESP	0.008	187						2/16/95	Nor
680C1	FF	0.018	319						11/11/93	
304C5	ESP	0.008	398						9/29/94	Nor, No Cd
335C8	ESP	0.028	438	5					1/1/86	
681C1	FF	0.014	918						11/10/93	

Part 2. Long non ILRM kilns not meeting MACT PM floor

300C7	ESP	0.044	219			1.1E+04		0.2	5/1/87	
402C4	ESP		6229		5.0E+03	4.2E+04			4/4/94	
305C3	ESP	0.08	728	34	5.6E+03	6.8E+04		0.2	8/20/92	
401C1	ESP	0.05	269	57	6.8E+03	7.4E+04		0.3	4/9/92	
318C2	ESP		133		1.0E+04	1.1E+05	99		5/24/93	
304C1	ESP	0.06	601		3.0E+03	1.4E+05		1	8/1/92	
205C1	ESP	0.05	1160		3.8E+03	1.4E+05		0.2	8/1/92	
401C5	ESP	0.08	1907	1	3.5E+03	1.5E+05		0.1	3/1/94	
305C1	ESP	0.06	409	100	6.9E+03	1.6E+05			3/1/93	
319C1	ESP	0.037	676		2.3E+03	2.0E+05		3	5/5/92	
402C1	ESP	0.033	419	100	2.6E+03	2.1E+05		0.1	3/27/92	
204C1	ESP	0.034	464		4.1E+03	2.2E+05		1	7/1/92	
491C1	ESP	0.06	948		1.5E+03	2.3E+05		3	8/15/95	
473C1	ESP		28	7		2.3E+05			5/8/95	
302C1	ESP	0.034	1722		1.4E+03	4.1E+05		0.1	8/1/92	

TABLE 8-2. CEMENT KILN SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
302C3	ESP	0.06	1302			4.5E+05			8/1/95	
300C2	ESP		2323		3.0E+03	4.6E+05			8/20/92	
320C2	FF		1						4/1/92	Nor
320C6	FF		3						8/1/92	B, Nor
205C7	ESP		21						6/20/95	Nor
319D9	ESP	0.09	183						9/1/96	Nor
335C7	ESP		223	7					1/1/86	B, Nor
472C1	ESP		444						5/1/91	
335C6	ESP		537	3					7/8/93	Nor
472C2	ESP		926						5/1/91	
335B2	ESP	0.030	1020						10/7/96	Nor
228C7	ESP	0.07	1075						10/1/88	
319D6	ESP		1177			1.6E+05			9/1/96	

Part 3. Short and/or in-line raw mill kilns

202C2	FF	0.031	110		2.9E+04	1.8E+05		0.3	10/1/92	ILRM
202C5	FF	0.030	230		3.5E+04				12/1/96	ILRM
303C9	QC/FF		2	3	9.3E+03	1.3E+04			12/1/95	Nor, Short, ILRM, CMBM
303C3	QC/FF		32		9.5E+03	2.7E+04			1/1/93	Short, ILRM, CMBM
303C7	QC/FF	0.025	6		7.0E+03	3.4E+04			12/1/95	Short, ILRM, CMBM
303C1	QC/FF	0.023	17		1.4E+04				1/1/93	B, Nor, Short, ILRM, CMBM
303C6	QC/FF	0.017	20						9/1/92	Short, ILRM, B, CMBM
321C5	ESP	0.018	6		5.9E+04	1.9E+05			8/1/95	Short, ILRM
321C5	ESP	0.011	11		5.9E+04	1.9E+05			8/1/95	Short, ILRM, BPM
321C1	ESP	0.06	11		3.5E+04	3.6E+05			8/1/92	Short, ILRM
321C1	ESP	0.040	306		3.5E+04	3.6E+05			8/1/92	Short, ILRM, BPM
321C4	ESP	0.007	1	13					10/13/93	Nor, Short, ILRM
321C3	ESP	0.005	1	27					10/13/93	B, Nor, Short, ILRM
321C4	ESP	0.001	1	100					10/13/93	Nor, Short, ILRM, BPM
321C3	ESP	0.004	3	19					10/13/93	B, Nor, Short, ILRM, BPM

TABLE 8-2. CEMENT KILN SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
Part 4. No longer burning hazardous waste										
308C1	ESP	0.021	86		3.0E+04	2.7E+04			8/21/92	NLBHW
317C2	FF	0.003	14	100	1.4E+04	4.2E+04		0.2	1/22/93	NLBHW, Short, ILMR
317C1	FF	0.002	14	100	5.9E+03	4.3E+04			1/22/93	NLBHW, Short, ILMR
306C1	MC/FF	0.017	17		1.3E+04	4.4E+04		1	5/1/93	NLBHW
316C2	FF	0.013	6		1.2E+04	6.6E+04		0.2	3/25/92	NLBHW, Short, CMBM
405C1	ESP	0.036	702	80	6.4E+03	7.8E+04			8/1/92	NLBHW, Short, CMBM
309C1	MC/ESP	0.026	567		3.9E+04	8.1E+04			10/1/92	NLBHW
316C1	FF	0.011	6		1.2E+04	8.3E+04		0.2	3/25/92	NLBHW, Short, CMBM
309C6	MC/ESP	0.010	725		5.9E+03	1.3E+05		0.1	7/1/96	NLBHW
406B4	ESP	0.016	336	100	1.8E+04	1.5E+05		18	8/1/92	NLBHW, Short, CMBM
406C4	ESP	0.021	66		6.3E+04	1.7E+05			8/1/95	NLBHW, Short, CMBM
301C2	FF		6	100	8.9E+03	2.7E+05		2	5/1/93	NLBHW, Short, ILMR
301C2	FF		2030	100	8.9E+03	2.7E+05		2	5/1/93	NLBHW, Short, ILMR, BPM
315C2	FF	0.001	7	100	1.4E+04	3.0E+05		0.1	7/15/92	NLBHW, Short, ILMR
315C2	FF	0.033	106	9	1.4E+04	3.0E+05		0.1	7/15/92	NLBHW, Short, ILMR, BPM
315C1	FF	0.001	15	54	1.5E+04	3.1E+05		0.1	7/15/92	NLBHW, Short, ILMR
315C1	FF	0.035	93	16	1.5E+04	3.1E+05		0.1	7/15/92	NLBHW, Short, ILMR, BPM
315C6	FF	0.003	2	14					4/16/91	B, Nor, NLBHW, Short, ILMR
315C5	FF	0.003	3						4/16/91	NLBHW, Short, ILMR
315C4	FF	0.007	3	15					4/16/91	NLBHW, Short, ILMR
317C3	FF	0.002	14	100	5.7E+03			1	1/22/93	B, Nor, NLBHW, Short, ILMR
469C1	ESP	0.034	16						1/31/90	Nor, NLBHW
315C6	FF	0.05	33	1					4/16/91	B, Nor, NLBHW, Short, ILMR, BPM
405C3	ESP	0.15	81						9/17/90	Nor, NLBHW, Short, CMBM
315C5	FF	0.041	104						4/16/91	NLBHW, Short, ILMR, BPM
315C4	FF	0.05	169						4/16/91	NLBHW, Short, ILMR, BPM

TABLE 8-3. LWAK SVM

EPA Cond ID	APCS	PM (gr/dscf)	SVM Emiss		SVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
Part 1. MACT PM floor control										
224C2	FF	0.001	11		6.2E+03	6.6E+03			8/1/96	Non-rep. MTEC
224C1	FF	0.005	3	52	7.3E+03	1.5E+04		7	8/1/93	Non-rep. MTEC
307C2	FF/VS	0.010	7		1.7E+04	5.2E+04	98		12/1/92	
307C4	FF/VS	0.007	4		1.7E+04	5.5E+04	96		12/1/92	
307C1	FF/VS	0.008	10		1.8E+04	5.7E+04	98		12/1/92	
307C3	FF/VS	0.022	4		1.8E+04	5.8E+04	82		12/1/92	
475C1	FF	0.003	43		7.1E+03	3.3E+05		1	6/23/93	
311C1	FF	0.006	468	19	6.2E+03	3.7E+05	97	0.4	8/8/92	
225C2	FF	0.001	4		1.0E+04	3.9E+05			8/1/96	
312C1	FF	0.010	407		9.9E+02	4.6E+05	100	0.4	8/8/92	
226C2	FF	0.002	95		1.7E+04	5.1E+05			8/26/97	
310C2	FF	0.012	231		6.5E+03	5.4E+05		4	8/16/95	
314C3	FF	0.003	35		1.3E+04	5.7E+05	99		3/18/96	
608C1	FF	0.010	64		1.0E+04	5.8E+05	98	0.1	3/1/96	
225C1	FF	0.001	2	18	1.4E+04	6.6E+05	98	1	8/1/93	
313C1	FF	0.007	689		1.4E+04	6.9E+05	96		8/8/92	
314C1	FF	0.025	1666		2.0E+04	7.0E+05	98	0.1	8/8/92	
474C1	FF	0.003	78		1.1E+05	7.2E+05	100		9/1/94	
223C1	FF	0.004	5	12	1.9E+04	7.3E+05	97		8/1/93	
226C1	FF	0.002	12		2.5E+04	7.4E+05	99		7/1/93	
476C1	FF	0.020	849		2.2E+04	8.2E+05	100		2/1/93	Nor
310C1	FF	0.018	506		5.5E+03	2.0E+06	100		8/12/92	
479C2	MC/HE/FF/VS/DM	0.017	7						8/1/90	B, Nor
479C1	MC/HE/FF/VS/DM	0.016	12	14					8/1/90	Nor
336C3	FF	0.002	34						5/1/95	
312C2	FF	0.013	447						5/1/95	

Part 2. No longer burning hazardous waste

227C1	FF	0.001	31		9.7E+05	2.4E+04			1/1/94	NLBHW
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CHAPTER 9

LOW VOLATILE METALS

The low volatile metals (LVM) group includes arsenic, beryllium, and chromium (total). As discussed for SVM, the grouping is based on generally similar behavior and control of these constituents in combustion systems. Also, as discussed for SVM, LVM are controlled through both limiting LVM feedrate in the hazardous waste and PM emissions control. LVM are relatively non-volatile at the typical temperatures within the combustion zone. LVM are typically contained in the bottom ash and entrained PM. Thus, the control of LVM emissions are related to PM control.

For the proposed rule, the data analysis method used to determine the MACT floor was identical to that used for SVM -- MACT control was based on the feedrate and SVM controlling air pollution control techniques used by the best performing sources. For the May 1997 NODA re-evaluation, the LVM floor was based on procedure identical to that discussed for SVM, involving:

- Identifying all LVM emissions data with corresponding PM test condition data at or below the PM MACT floor level.
- Determining a LVM MACT floor standard that is reasonably achievable based on the LVM emissions data identified in the previous step. This involves screening the data set by a breakpoint emissions evaluation to remove “outlier” conditions that may be a result of non-typical feed rates, measurement inaccuracies, high detection limits, etc.

Similar to that discussed in the previous chapter for SVM, due to a variety of concerns with the May 1997 NODA approach, the final rule approach uses the “Aggregate Feedrate” analysis procedure to define a MACT hazardous waste feedrate MTEC. This is discussed in Chapter 2, with results presented in Chapter 6. As for SVM, the LVM standard is based on facilities using MACT control, involving meeting the MACT hazardous waste MTEC limit and using MACT floor PM control.

9.1 INCINERATORS

Table 9-1 summarizes all LVM test condition data from HWIs. As for SVM, the table is divided into three sections. The first part contains all test conditions from incinerators that are using MACT PM floor control (FF, IWS, or ESP and meeting the floor level of 0.015 gr/dscf, for both new and existing sources) and are still burning hazardous waste. The conditions are ranked by hazardous waste MTEC. The second part contains test conditions from facilities that are not meeting the MACT PM floor control and are burning hazardous waste. The last part contains test conditions from incinerators that are no longer burning hazardous wastes.

The data are from over 40 different HWIs. Stack gas emissions condition averages range widely from 4 to over 130,000 µg/dscm.

9.1.1 Existing Sources Floor

MACT floor control for existing sources for LVM involves control of LVM in the hazardous waste and the use of MACT floor PM control. As discussed in Chapter 4, MACT floor PM control includes the use of either a FF, IWS, or ESP and meeting the floor level of 0.015 gr/dscf. As identified in Chapter 6 from the MACT Aggregate Feedrate approach, the LVM MACT defining hazardous waste feedrate MTEC is 2.4×10^4 µg/dscm. Note that:

- Hazardous waste feedrate MTECs from sources using the MACT PM control have a wide range from 300 to 1.4×10^6 µg/dscm. About 60% of MTECs from sources meeting the MACT PM level are less than this MACT MTEC level.
- Hazardous waste feedrate MTECs from all incinerators range from 5 to 1.7×10^6 µg/dscm. Over 70% of the MTECs from the entire incinerator universe are less than the MACT MTEC level.

The resulting MACT floor is 97 µg/dscm, corresponding to the highest test condition average from Source ID No. 325C7 using MACT. MACT is defined as having PM floor control (PM less than 0.015 gr/dscf and using FF, IWS, or ESP) and an LVM hazardous waste MTEC less than the MACT MTEC of 2.4×10^4 µg/dscm. Note that:

- LVM emissions from incinerators meeting the PM MACT floor (29 different test conditions) range from 1 to 803 µg/dscm, although only 2 of the 29 testing conditions are

higher than the MACT floor level of 97 $\mu\text{g}/\text{dscm}$. These two are screened out because the feedrates are higher than the MACT defining level.

- Almost 80% of all incinerator LVM emissions are less than the MACT floor level of 97 $\mu\text{g}/\text{dscm}$.

9.1.2 New Source Floor

MACT floor control for LVM for new sources involves control of LVM in the hazardous waste and the use of MACT floor PM control. MACT floor control for PM for new sources is identical to that for existing sources (meeting a PM level of 0.015 gr/dscf and using FF, ESP, or IWS). As identified in Chapter 6 from the MACT Aggregate Feedrate approach, the LVM MACT defining hazardous waste feedrate MTEC is 1.3×10^4 $\mu\text{g}/\text{dscm}$. The resulting LVM MACT floor is 97 $\mu\text{g}/\text{dscm}$.

9.2 CEMENT KILNS

Table 9-2 summarizes all LVM test condition data from CKs. As for LVM, the table is divided into four parts. The first part contains test conditions from long and non in-line raw mill kilns meeting the MACT PM floor and currently burning hazardous waste. Conditions are ranked by hazardous waste feedrate MTEC. The second part contains test conditions from long and non in-line raw mill kilns that are not meeting the PM floor. The third part contains test conditions from short and in-line raw mill kilns. The last part contains test conditions from kilns no longer burning hazardous waste.

The data are from 34 different CKs. Stack gas condition averages range from 4 to 520 $\mu\text{g}/\text{dscm}$, with most less than 70 $\mu\text{g}/\text{dscm}$. LVM SREs in CKs typically are greater 99.95%, with some exceeding 99.99%.

9.2.1 Existing Sources Floor

MACT floor control for LVM for existing sources involves control of LVM in hazardous waste and using MACT floor control for PM. As discussed in Chapter 4, the PM MACT floor limit is 0.03 gr/dscf (the equivalent of the NSPS). As identified in Chapter 6, the CK LVM MACT defining hazardous waste MTEC is 5.4×10^4 $\mu\text{g}/\text{dscm}$. Note that about 40% of the entire universe of CK LVM hazardous waste feedrate MTECs (and only those meeting the MACT PM level) are less than this MACT defining level.

The resulting MACT floor is 56 µg/dscm, which is the highest test condition average using MACT of both PM less than 0.03 gr/dscf and an LVM hazardous waste MTEC of less than the MACT MTEC of 5.4×10^4 µg/dscm. About 90% of all CK LVM emissions levels are meeting the MACT floor. Also, about 90% of those with PM less than 0.03 gr/dscf are meeting the MACT floor.

A LVM floor level of 56 µg/dscm is achievable by short kilns with alkali bypasses and kilns with in-line raw mills because:

- No. 202 (long kiln with in-line raw mill) has LVM emissions data from two conditions at 25 and 28 µg/dscm.
- No. 321 (short kiln with separate bypass and main stacks and in-line raw mill) has several LVM test conditions with measurements made at both the bypass and main stack and with the in-line raw mill off and on. All measurements are less than 10 µg/dscm.
- No. 303 (short kiln with combined bypass/main stack and in-line raw mill) has several combined bypass/main stack measurements ranging from 2 to 33 µg/dscm.

Note that as discussed above in Chapters 2 and 6, a significant fraction of the LVM in cement kilns partitions into the clinker product. LVM does not tend to become concentrated in the bypass gases or build up an internal recycle to the same extent as SVM (i.e., LVMs are not enriched in the CKD in the bypass or main stack as SVMs are). Stack gas data from both bypass and main stacks are available for comparison for three kilns. For one facility (Source ID No. 321), bypass emissions concentrations are slightly lower than those from the main stack. For another (Source ID No. 301, no longer burning waste), the bypass is about five times higher than the main stack. For another (Source ID No. 315, also no longer burning waste), the bypass is about three times higher than the main stack. Differences may be due to different bypass gas ratios, different main and bypass stack APCD efficiencies, and different ratios of LVM feed rates in raw material and hazardous wastes. In any case, metals with low volatility are not expected to be enriched in the bypass gas. Additionally, LVM uncontrolled loadings in the bypass and main stack gases are not expected to be significantly different, although there may be some difference due to entrained raw materials LVM contributions in the main stack. There are no expected differences in the ability to control LVM in the bypass stack as compared to the main stack. There is also no strongly expected influence of in-line raw mill operational status on LVM emissions.

9.2.2 New Sources Floor

MACT floor control for LVM involves control of LVM in hazardous waste and using floor control for PM. The PM MACT floor is 0.03 gr/dscf (equivalent of the NSPS), identical to that for existing sources. As identified in Chapter 6, the CK LVM MACT defining hazardous waste MTEC is 1.5×10^4 µg/dscm. The resulting LVM MACT floor is 54 µg/dscm.

9.3 LIGHTWEIGHT AGGREGATE KILNS

Table 9-3 summarizes all LVM test condition data from LWAKs. As for SVM, the table is divided into two sections. The first section contains test conditions from kilns currently burning hazardous waste and using MACT floor PM control. Note that all LWAK test conditions meet the MACT PM floor. The second set contains the single facility that is no longer burning hazardous waste.

The data are from 22 different conditions from 15 different LWAKs. Stack gas emissions test condition averages range from 10 to 130 µg/dscm. SREs for LVM in LWAKs are, like cement kilns, typically greater than 99.9%, with some above 99.99%.

9.3.1 Existing Sources Floor

MACT control for LVM for existing sources involves the use of LVM feed control in the hazardous waste and PM MACT floor control. The PM MACT floor is 0.025 gr/dscf, as discussed in Chapter 4. As identified in Chapter 6, based on the Aggregate Feedrate approach, the LVM MACT defining hazardous waste MTEC is 1.2×10^5 µg/dscm. Note that the LWAK hazardous waste LVM MTECs range from 2.0×10^4 to 1.8×10^5 µg/dscm and that almost 90% of all of the LWAK LVM hazardous waste feedrate MTECs are less than the MACT level.

The resulting MACT floor is 110 µg/dscm, which is the highest test condition average using MACT. MACT is defined as operations with both PM less than 0.025 gr/dscf and an LVM hazardous waste MTEC of less than the MACT MTEC of 1.2×10^5 µg/dscm. This is the second highest out of the 22 test conditions.

9.3.2 New Source Floor

MACT control for LVM for new sources involves the use of LVM feed control in the hazardous waste and PM MACT floor control. The PM MACT floor is 0.025 gr/dscf, identical to

that for existing sources. As identified in Chapter 6, based on the Aggregate Feedrate approach, the LVM MACT defining hazardous waste MTEC is $4.6 \times 10^4 \mu\text{g/dscm}$. In conjunction with the PM floor, the resulting LVM MACT floor is $110 \mu\text{g/dscm}$.

TABLE 9-1. INCINERATOR LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
Part 1. MACT PM floor control									
341C1	DA/DI/FF/HEPA/CA	0.003	10	100		3.3E+02	100	10/1/93	OS
341C2	DA/DI/FF/HEPA/CA	0.001	10	100		6.6E+02	58	10/1/93	OS
348C4	QC/AS/IWS	0.0003	1	62		2.1E+03	26	4/16/95	OS
325C5	SD/FF/WS/IWS	0.004	46			2.4E+03	0	12/1/90	Comm
337C1	WHB/DA/DI/FF	0.0003	21	94		2.5E+03	0	2/28/92	WHB, OS
325C7	SD/FF/WS/IWS	0.005	97			3.2E+03	0	12/1/90	Comm
325C4	SD/FF/WS/IWS	0.004	12	3		3.9E+03	0	12/1/90	Comm
348C3	QC/AS/IWS	0.0002	5	2	9.5E+01	6.1E+03	22	4/16/95	OS
348C1	QC/AS/IWS	0.002	3	18	1.0E+02	6.1E+03	4	2/10/94	OS, No Be
325C6	SD/FF/WS/IWS	0.002	31			6.8E+03	0	12/1/90	Comm
601C2	WHB/DS/FF/WS	0.011	14	3		7.2E+03	0	5/1/96	WHB, Comm
601C1	WHB/DS/FF/WS	0.005	10			1.1E+04	0	5/1/96	WHB, Comm
603C8	QT/S/IWS	0.002	12	2	5.0E+02	1.3E+04	0	5/20/90	Comm
354C1	QC/AS/VS/DM/IWS	0.001	3	100	8.7E+00	1.4E+04	0	4/1/92	OS, No Be
340C2	WHB/ESP/WS	0.005	3	93		2.4E+04	1	9/1/92	WHB, OS
222B3	WHB/SD/CI/ESP/Q/PBS	0.003	2	44		3.0E+04		9/12/95	Nor, WHB, Comm
340C1	WHB/ESP/WS	0.008	138	4		3.6E+04	1	9/1/92	WHB, OS
602C2	Q/S/C/DM/HEPA	0.002	5		3.7E+01	5.3E+04	0	7/15/97	OS
602C1	Q/S/C/DM/HEPA	0.002	9		1.2E+02	5.7E+04	0	7/15/97	OS
602C3	Q/S/C/DM/HEPA	0.002	6		8.4E+01	6.8E+04	0	7/15/97	OS
209C1	WHB/FF/VQ/PT/DM	0.001	12			8.3E+04		6/20/91	WHB, Comm
209C2	WHB/FF/VQ/PT/DM	0.001	8			9.8E+04		6/20/91	WHB, Comm
348C2	QC/AS/IWS	0.0003	8	2	9.0E+01	1.4E+05	1	4/16/95	OS
327C3	SD/FF/WS/WESP	0.001	11	48		1.7E+05	2	8/1/92	Comm
327C2	SD/FF/WS/WESP	0.002	13	29		2.5E+05	7	8/1/92	Comm
327C1	SD/FF/WS/WESP	0.001	31	12		4.4E+05	2	8/1/92	Comm
601C3	WHB/DS/FF/WS	0.003	10	2		7.6E+05	0	5/1/96	WHB, Comm
222C1	WHB/SD/CI/ESP/Q/PBS	0.003	11	58		1.3E+06		5/1/93	WHB, Comm
331C3	Q/PT/IWS/DM	0.015	803			1.4E+06		5/1/92	Comm, No Be
351C2	C/HE/FF	0.004	3					1/31/92	OS, Cr only
351C1	C/HE/FF	0.005	3					1/31/92	OS, Cr only

TABLE 9-1. INCINERATOR LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
325C8	SD/FF/WS/IWS	0.0004	4	53				10/6/94	Nor, Comm
603B3	QT/S/IWS	0.002	5	1				10/19/94	Comm
351C3	C/HE/FF	0.012	6					1/31/92	OS, Cr only
603C3	QT/S/IWS	0.006	14	1				9/21/92	Comm
353C1	QC/VS/DM/WESP	0.008	14	100				7/1/89	OS
600C3	WHB/QC/PT/IWS	0.003	16					12/14/95	WHB, OS, No Be
471C1	QT/FF	0.003	24	16				3/1/95	OS
338C2	QC/FF/SS/C/HES/DM	0.001	24	68				8/1/90	OS
331C1	Q/PT/IWS/DM	0.008	37	1				3/1/93	Comm
359C5	WHB/FF/S	0.009	37	99				6/1/90	WHB, Comm
338C1	QC/FF/SS/C/HES/DM	0.001	55	33				8/1/90	Nor, OS
359C4	WHB/FF/S	0.003	113	29				6/1/90	WHB, Comm
353C2	QC/VS/DM/WESP	0.011	326	4				7/1/89	OS

Part 2. MACT PM control (FF, IWS or ESP) but not meeting PM floor

705C1	QT/VS/PT/WESP	0.073	31	25		5.1E-01	40	3/22/90	OS
705C2	QT/VS/PT/WESP	0.052	28	1		1.0E+03	3	3/22/90	OS
334C2	WHB/Q/WS/WESP/PT/WS	0.058	388	0.1		4.9E+03	14	9/6/90	WHB, OS
334C1	WHB/Q/WS/WESP/PT/WS	0.062	370	0.3		1.6E+04	1	9/6/90	WHB, OS
354C5	QC/AS/VS/DM/IWS		5			2.5E+04		9/1/92	OS, No Be
214C2	Q/IWS	0.028	52			5.7E+04		5/3/88	Comm, No Be
214C3	Q/IWS	0.019	25			8.8E+04		5/3/88	Comm, No Be
331C2	Q/PT/IWS/DM	0.024	590			3.1E+05		5/1/92	Comm
325C3	SD/FF/WS/IWS		2	4				12/1/91	Comm
334C3	WHB/Q/WS/WESP/PT/WS	0.048	32					3/11/88	Nor, WHB, OS
503C3	C/HE/FF	0.016	36	11				5/30/91	OS
503C2	C/HE/FF	0.029	42	2				3/1/93	OS
214C1	Q/IWS	0.017	57	26				4/28/87	Comm
503C1	C/HE/FF	0.028	112	1				3/1/93	OS
1001C2	C/HE/FF	0.010	114					12/6/93	OS
1001C5	C/HE/FF	0.013	135					12/6/93	OS
1001C3	C/HE/FF	0.009	241					12/6/93	OS

TABLE 9-1. INCINERATOR LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
503C4	C/HE/FF	0.019	432	0.5				5/30/91	OS
359C6	WHB/FF/S	0.077	639	24				6/1/90	WHB, Comm

Part 3. Not using MACT PM floor control

712C1	WHB	0.038	51	1		1.2E+00	23	2/1/93	WHB, OS
712C2	WHB	0.023	10	4		2.1E+00	18	10/1/92	WHB, OS
221C1	SS/PT/VS	0.014	46	6		7.2E+01	77	8/1/88	Comm
229C3	WHB/ACS/HCS/CS	0.017	62	1		2.5E+02	1	2/12/91	WHB, OS, No Be
221C4	SS/PT/VS	0.015	139	1		3.5E+02	61	8/1/88	Comm
229C5	WHB/ACS/HCS/CS	0.031	66	1		5.8E+02		2/12/91	WHB, OS, No Be
229C1	WHB/ACS/HCS/CS	0.010	37	1		6.8E+02	7	4/16/91	WHB, OS, No Be
229C6	WHB/ACS/HCS/CS	0.026	57	1		7.9E+02		2/12/91	WHB, OS, No Be
221C2	SS/PT/VS	0.015	15	15		9.3E+02	22	8/1/88	Comm
229C2	WHB/ACS/HCS/CS	0.012	52	1		1.3E+03	5	4/16/91	WHB, OS, No Be
324C3	WHB	0.014	101			3.2E+03		2/1/89	WHB, Comm
324C2	WHB	0.023	95			3.3E+03		2/1/89	WHB, Comm
324C4	WHB	0.029	174			3.8E+03		2/1/89	WHB, Comm
324C1	WHB	0.018	82			5.4E+03		2/1/89	WHB, Comm
700C1	SD/RJS/VS/WS	0.057	674		4.2E+00	6.6E+03	0	11/1/92	OS
905C1	QT/VS/AS/CS		98			6.8E+03	1	2/20/90	OS
824C1	QT/VS/PT/DM	0.006	90	0.3		8.4E+03	0	10/1/89	OS
221C5	SS/PT/VS	0.013	125	0.1		9.6E+03	3	8/1/88	Comm
221C3	SS/PT/VS	0.013	23	3		1.2E+04	1	8/1/88	Comm
706C4	QT/HS/C/DM		1457			1.7E+04		4/1/94	OS, No Cr
490C1	SS/PBS	0.011	39			2.0E+04	0	6/1/94	OS
810C1	WHB/Q/VS/PBS		96			2.4E+04	0	8/30/91	OS, No Be
809C1	WHB/Q/VS		146			3.0E+04	0	8/30/91	OS, No Be
458C2	VS/PT/QT	0.018	191			3.8E+04	0	10/1/90	OS
504C1	VS/C	0.021	160	0.37	1.9E+01	1.2E+05	0	10/11/91	OS
809C2	WHB/Q/VS		752			4.7E+05	0	8/30/91	OS, No Be
489C1	SS/PT/VS/DM	0.013	14	23		5.8E+05	0	10/1/89	Comm
488C2	SS/PT/VS/DM	0.010	31	6		9.1E+05	0	9/1/89	Comm

TABLE 9-1. INCINERATOR LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
810C2	WHB/Q/Vs/PBS		172			1.0E+06	0	8/30/91	OS, No Be
488C1	SS/PT/Vs/DM	0.013	47	2		1.1E+06	0	9/1/89	Comm
488C3	SS/PT/Vs/DM	0.008	25	7		1.7E+06	0	9/1/89	Comm
494C1	C/QT/Vs/PBS/DM	0.035	2					8/15/97	OS
493C1	C/QT/Vs/PBS/DM	0.002	2					7/7/97	OS
342C1	WHB/QC/S/Vs/DM	0.004	3					3/16/92	WHB, OS, No Be
344C1	QC/Vs/PT/DM	0.001	4					6/23/92	OS, Cr only
347C8	C/QT/Vs/PBS/DM	0.004	5	6				4/9/97	OS
347C1	C/QT/Vs/PBS/DM	0.012	6	15				10/1/93	OS
346C1	C/QC/Vs/PT/DM	0.001	6	6				6/23/92	OS, No As
806C2	C/Vs	0.031	7					6/1/89	OS
347C2	C/QT/Vs/PBS/DM	0.003	7	13				10/1/93	B, Nor, OS
347C7	C/QT/Vs/PBS/DM		7					2/26/93	B, Nor, OS, Cr only
806C1	C/Vs	0.056	8	2				6/1/89	OS
344C2	QC/Vs/PT/DM	0.002	9	71				6/17/91	OS, As only
347C5	C/QT/Vs/PBS/DM		10					2/26/93	B, Nor, OS, Cr only
347C6	C/QT/Vs/PBS/DM		12					2/26/93	B, Nor, OS, Cr only
711C4	C/WHB/Vs/AS	0.024	13					4/1/97	WHB, OS
604C1	HS		14	1				3/1/96	OS
344C3	QC/Vs/PT/DM	0.001	15	35				2/1/93	OS, No Be
347C4	C/QT/Vs/PBS/DM	0.001	15	9				4/1/92	B, Nor, OS
470C1	QT/Vs/PBS/DM	0.002	17	11				12/16/92	OS, No Be
605C1	WS	0.008	26	100				12/8/93	Nor, OS, No Be
347C3	C/QT/Vs/PBS/DM	0.011	30	5				4/1/92	OS
216C6	HES/WS	0.027	37	4				8/1/88	Comm
725C1	WS/QT	0.022	41	2				6/19/90	OS
216C5	HES/WS	0.033	43	6				8/1/88	Comm
216C7	HES/WS	0.021	43	15				2/1/90	Comm
609C1	SS/PT/Vs/DM	0.013	82	0.1				4/1/95	Comm
1001C4	C/HE/FF	0.020	122					12/6/93	OS
915C4	QC/Vs/C	0.071	142					9/1/92	OS, Cr only
216C3	HES/WS		266	0.2				12/1/86	Comm
915C1	QC/Vs/C	0.076	312					9/1/92	OS, No Be

TABLE 9-1. INCINERATOR LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)			Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	ND (%)		
480C3	QC/HS	0.029	4269			1.0E+05		5/31/94	OS

Part 4. No longer burning hazardous waste

330C2	QT/PBS/DM	0.059	25	12	2.0E+01	9.8E+00	1	4/1/91	NLBHW, Comm
500C1	QC/VS/KOV/DM	0.002	2	0.1		5.2E+02	68	7/18/88	NLBHW, OS
902C1	QT/VS/PT	0.021	5	29		1.0E+03		12/1/93	NLBHW, OS
356C2	QC/AS/FN/PBS/DM		212			2.2E+03		10/21/90	NLBHW, OS, No As
400C1	SD/FF	0.006	52	53	5.2E+05	8.2E+03		7/1/91	NLBHW, Comm
502C1	WHB/QC/PBC/VS/ES	0.036	26	100		1.1E+04		7/1/90	NLBHW, WHB, OS
329C1	PT/IWS	0.031	417	0.1	2.8E+00	1.6E+04	0	3/27/92	NLBHW, Comm
710C5	QT/OS/C/S	0.025	41			1.4E+05	0	9/9/93	NLBHW, OS, No Be
807C1	C/WHB/VQ/PT/HS/DM	0.034	58	44		2.3E+05	9	7/18/91	NLBHW, WHB, OS
807C3	C/WHB/VQ/PT/HS/DM	0.028	26	87		2.6E+05	6	7/18/91	NLBHW, WHB, OS
807C2	C/WHB/VQ/PT/HS/DM	0.022	64	43		3.6E+05	5	7/18/91	NLBHW, WHB, OS
330C1	QT/PBS/DM	0.023	31	11	6.2E+00		0	4/1/91	NLBHW, Comm
332C3	HES	0.063	102					4/6/87	NLBHW, Comm, No

TABLE 9-2. CEMENT KILN LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (μg/dscm)				Cond Date	Summary Comments
			Stack Actual (μg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
Part 1. Long non ILRM kilns using MACT PM floor control										
208C2	ESP	0.016	13	5	7.9E+03	7.2E+03	98	20	1/1/93	
323B2	ESP	0.020	5	0.3	2.5E+04	9.9E+03		1	6/1/96	
323C9	ESP	0.005	4	12	3.9E+04	1.3E+04		0	6/1/96	
207C2	MC/ESP	0.018	54	1	5.9E+03	1.4E+04	92	6	1/1/93	
208C1	ESP	0.014	9	8	4.2E+03	1.5E+04	99	6	1/1/93	
207C1	MC/ESP	0.028	56	1	5.1E+03	1.6E+04	96	6	1/1/93	
320C1	FF	0.003	3		8.4E+03	2.5E+04		1	8/1/92	
335C1	ESP	0.023	3	100	7.7E+03	3.9E+04	83	3	6/1/92	
203C1	ESP	0.014	20	1	4.4E+03	4.7E+04	90	0	8/19/93	
320C3	FF	0.002	2		1.5E+04	5.4E+04	93	0	8/1/95	
203C5	ESP	0.009	2	100	1.2E+04	6.2E+04		0	8/16/96	
204B3	ESP	0.012	8		2.4E+03	9.7E+04	97	0	9/13/96	
323B3	ESP	0.026	6		2.1E+04	1.1E+05	60	0	11/1/95	
205C5	ESP	0.002	10	1	2.9E+04	1.2E+05		0	9/15/95	
322C8	ESP	0.013	14		1.6E+04	1.3E+05	71	0	11/1/95	
206C5	ESP	0.029	20		2.8E+04	1.3E+05		0	9/15/95	
206C1	ESP	0.023	7	14	2.5E+04	1.6E+05	98	0	8/1/92	
403C1	ESP	0.029	14	100	4.2E+03	1.6E+05	75	3	10/1/92	
404C1	ESP	0.007	9	100	5.5E+03	1.7E+05	70	1	11/1/92	
322C1	ESP	0.019	18		9.4E+03	1.7E+05	82	1	8/1/92	
404C4	ESP	0.004	5		4.6E+03	1.8E+05		1	1/17/95	
403C3	ESP	0.029	14	3	3.4E+03	1.9E+05	92	0	11/1/94	
323C1	ESP	0.022	62		1.2E+04	2.0E+05	86	2	8/1/92	
201C1	FF	0.011	76		8.1E+03	3.0E+05	98	5	8/21/92	
228C2	ESP	0.013	16	5	5.0E+03	3.0E+05		0	5/1/92	
200C4	FF	0.004	6		2.0E+04	3.2E+05	99		8/1/95	
200C1	FF	0.013	60		8.0E+03	3.5E+05	99	3	8/21/92	
200C5	FF	0.002	9	1	1.6E+04	5.1E+05	99.1		8/1/95	
208C3	ESP	0.017	0.3	100					1/1/97	No Cr
207C3	MC/ESP	0.007	0.4	100					1/1/97	No Cr
319D2	ESP	0.009	1						2/16/95	

TABLE 9-2. CEMENT KILN LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
319D1	ESP	0.008	2						2/16/95	Nor
320C5	FF	0.014	2	100					1/17/95	Nor
203C4	ESP	0.016	2	3					12/1/93	No As
305B3	ESP	0.008	4	2					10/7/96	Nor
204B2	ESP	0.008	5	1					9/13/96	Nor
323B1	ESP	0.012	7		4.5E+04			0	6/1/96	B
681C2	FF	0.015	15	28					6/5/91	No Be
203C2	ESP	0.018	16	15					5/24/94	
201C2	FF	0.024	34	0.1					1/30/91	
300C6	ESP	0.023	39	9					5/1/87	B, Nor, old data, No Be
680C1	FF	0.018	43	5					11/11/93	
228C6	ESP	0.026	415	1					10/1/88	Old data
681C1	FF	0.014	475						11/10/93	
335C8	ESP	0.028	4985	0.1					1/1/86	Old data, No Be

Part 2. Long non ILRM kilns not meeting MACT PM floor

335B2	ESP	0.030	11	1					10/7/96	Nor
402C1	ESP	0.033	14	100	8.6E+03	2.0E+05		1	3/27/92	
302C1	ESP	0.034	22		4.1E+04	2.0E+05		0	8/1/92	
204C1	ESP	0.034	3	45	2.0E+04	1.5E+05		8	7/1/92	
335C6	ESP	0.035	4	38					7/8/93	Nor
319C1	ESP	0.037	60		8.9E+03	2.0E+05		2	5/5/92	
300C7	ESP	0.044	23	18	0.0E+00	3.4E+03		0	5/1/87	No Be
401C1	ESP	0.048	13	100	1.1E+04	3.0E+04		4	4/9/92	
205C1	ESP	0.050	13	3	2.1E+04	1.3E+05		0	8/1/92	
304C1	ESP	0.056	55		3.8E+04	1.7E+05		0	8/1/92	
302C3	ESP	0.060	20		8.5E+04	3.1E+05		0	8/1/95	
491C1	ESP	0.063	75		5.0E+03	2.5E+05		10	8/15/95	
305C1	ESP	0.063	8	100	6.5E+03	8.8E+04		0	3/1/93	
228C7	ESP	0.069	233	2					10/1/88	
401C5	ESP	0.077	18	53	5.1E+03	1.2E+04		2	3/1/94	
305C3	ESP	0.077	4	100	2.2E+04	4.4E+04		2	8/20/92	

TABLE 9-2. CEMENT KILN LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
335C7	ESP	0.094	5777	0.2					1/1/86	B, Nor, old data, No Be
472C1	ESP	0.100	9						5/1/91	
472C2	ESP	0.900	8						5/1/91	
318C2	ESP		2	100	2.5E+02	2.3E+02		0	5/24/93	
402C4	ESP		50		9.5E+03	1.8E+04		0	4/4/94	
473C1	ESP		6	82	0.0E+00	5.8E+04		0	5/8/95	
319D6	ESP		7	56	6.3E+03	1.5E+05	97		9/1/96	
300C2	ESP		63		2.8E+03	4.3E+05		0	8/20/92	
319D9	ESP		1	21					9/1/96	Nor
320C6	FF		3						8/1/92	B, Nor
320C2	FF		4						4/1/92	Nor, Cr only
205C7	ESP		41	0.4					6/20/95	Nor

Part 3. Short and/or in-line raw mill kilns

202C2	FF	0.031	25	9	1.2E+04	1.2E+05		0	10/1/92	ILRM
202C5	FF	0.030	28	7	1.2E+04			0	12/1/96	ILRM
303C9	QC/FF		1	8	2.2E+04	5.7E+03		0	12/1/95	Nor, Short, ILRM, CMBM
303C3	QC/FF		8		1.4E+04	2.5E+04		0	1/1/93	Short, ILRM, CMBM
303C7	QC/FF	0.025	2	4	2.1E+04	2.9E+04		0	12/1/95	Short, ILRM, CMBM
303C6	QC/FF	0.017	12						9/1/92	Short, ILRM, B, CMBM
303C1	QC/FF	0.023	33		5.6E+03			0	1/1/93	B, Nor, Short, ILRM, CMBM
321C1	ESP	0.040	7		2.2E+05	1.4E+05		0	8/1/92	Short, ILRM, BPM
321C1	ESP	0.060	9		2.2E+05	1.4E+05		0	8/1/92	Short, ILRM
321C5	ESP	0.018	4		9.2E+04	1.7E+05		0	8/1/95	Short, ILRM
321C5	ESP	0.011	4		9.2E+04	1.7E+05		0	8/1/95	Short, ILRM, BPM
321C3	ESP	0.004	1	100					10/13/93	B, Nor, Short, ILRM, BPM
321C4	ESP	0.001	1	75					10/13/93	Nor, Short, ILRM, BPM
321C4	ESP	0.007	1	76					10/13/93	Nor, Short, ILRM
321C3	ESP	0.005	7	8					10/13/93	B, Nor, Short, ILRM

Part 4. No longer burning hazardous waste

TABLE 9-2. CEMENT KILN LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
308C1	ESP	0.021	6		3.9E+04	2.7E+04		0	8/21/92	NLBHW
317C2	FF	0.003	10	100	5.7E+04	3.5E+04		0	1/22/93	NLBHW, Short, ILM
317C1	FF	0.002	10	97	4.0E+04	3.9E+04		0	1/22/93	NLBHW, Short, ILM
316C2	FF	0.013	4	17	3.0E+04	4.4E+04		0	3/25/92	NLBHW, Short, CMBM
316C1	FF	0.011	9	8	3.3E+04	6.4E+04		0	3/25/92	NLBHW, Short, CMBM
309C1	MC/ESP	0.026	7	12	2.8E+04	8.3E+04		0	10/1/92	NLBHW
301C2	FF		13	100	9.5E+04	8.3E+04		0	5/1/93	NLBHW, Short, ILM
301C2	FF		49	100	9.5E+04	8.3E+04		0	5/1/93	NLBHW, Short, ILM, BPM
309C6	MC/ESP	0.010	43	85	2.3E+04	1.5E+05		0	7/1/96	NLBHW
406B4	ESP	0.016	27	100	2.7E+04	1.7E+05		17	8/1/92	NLBHW, Short, CMBM
406C4	ESP	0.021	10		2.0E+04	1.7E+05		0	8/1/95	NLBHW, Short, CMBM
405C1	ESP	0.036	30	100	1.6E+04	1.7E+05		1	8/1/92	NLBHW, Short, CMBM
306C1	MC/FF	0.017	44		2.7E+04	3.2E+05		0	5/1/93	NLBHW
315C2	FF	0.001	5	100	5.8E+04	4.8E+05		0	7/15/92	NLBHW, Short, ILM
315C2	FF	0.033	18	98	5.8E+04	4.8E+05		0	7/15/92	NLBHW, Short, ILM, BPM
315C1	FF	0.001	5	98	5.1E+04	4.9E+05		0	7/15/92	NLBHW, Short, ILM
315C1	FF	0.035	17	98	5.1E+04	4.9E+05		0	7/15/92	NLBHW, Short, ILM, BPM
315C6	FF	0.003	2	8					4/16/91	B, Nor, NLBHW, Short, ILM
315C4	FF	0.007	2	4					4/16/91	NLBHW, Short, ILM
315C5	FF	0.003	3	4					4/16/91	NLBHW, Short, ILM
469C1	ESP	0.034	4						1/31/90	Nor, NLBHW
317C3	FF	0.002	10	100	4.1E+04			0	1/22/93	B, Nor, NLBHW, Short, ILM
315C5	FF	0.041	12	0.3					4/16/91	NLBHW, Short, ILM, BPM
315C6	FF	0.050	13	0.3					4/16/91	B, Nor, NLBHW, Short, ILM, BPM
405C3	ESP	0.154	13	0.2					9/17/90	Nor, NLBHW, Short, CMBM, No As
315C4	FF	0.052	17	0.2					4/16/91	NLBHW, Short, ILM, BPM

TABLE 9-3. LWAK LVM

EPA Cond ID	APCS	PM (gr/dscf)	LVM Emiss		LVM MTECs (µg/dscm)				Cond Date	Summary Comments
			Stack Actual (µg/dscm)	ND (%)	Other	HW	S/HW (%)	ND (%)		
Part 1. MACT PM floor control										
224C2	FF	0.001	9	23	1.3E+04	2.6E+03			8/1/96	Non-rep. MTEC
224C1	FF	0.005	8	17	3.2E+04	5.6E+03		0.2	8/1/93	Non-rep. MTEC
223C1	FF	0.004	22	1	5.6E+04	7.1E+03	73		8/1/93	
310C1	FF	0.018	37	6	5.2E+03	2.8E+04	99	2	8/12/92	
311C1	FF	0.006	22	80	8.5E+04	4.0E+04	95		8/8/92	
307C3	FF/VS	0.022	112	0.4	5.2E+04	4.5E+04	93		12/1/92	
475C1	FF	0.003	13		6.6E+04	4.6E+04	97	0.03	6/23/93	
312C1	FF	0.010	24	54	8.3E+04	4.6E+04	98		8/8/92	
307C2	FF/VS	0.010	24	0.2	5.7E+04	4.6E+04	99		12/1/92	
307C4	FF/VS	0.007	51	0.2	5.3E+04	4.8E+04	98		12/1/92	
314C1	FF	0.025	91	32	4.3E+04	5.0E+04	88	0.1	8/8/92	
307C1	FF/VS	0.008	59	1	7.0E+04	5.0E+04	99		12/1/92	
313C1	FF	0.007	32	39	4.3E+04	6.1E+04	63	0.03	8/8/92	
476C1	FF	0.020	111		2.4E+04	6.2E+04	89		2/1/93	Nor
474C1	FF	0.003	33	1	1.0E+05	6.4E+04	85		9/1/94	
225C1	FF	0.001	14	12	4.5E+04	7.2E+04	77	33	8/1/93	
226C1	FF	0.002	36		4.4E+04	8.6E+04	100		7/1/93	
314C3	FF	0.003	16	0.3	5.1E+04	9.5E+04	92		3/18/96	
225C2	FF	0.001	18	10	4.3E+04	1.2E+05			8/1/96	
226C2	FF	0.002	30	5	7.9E+04	1.4E+05			8/26/97	
608C1	FF	0.010	91		4.6E+04	1.4E+05	95		3/1/96	
310C2	FF	0.012	58		5.2E+04	1.8E+05	97		8/16/95	
479C2	MC/HE/FF/VS/DM	0.017	13						8/1/90	B, Nor, No Be
479C1	MC/HE/FF/VS/DM	0.016	17						8/1/90	Nor, No Be
336C3	FF	0.002	20	4					5/1/95	
312C2	FF	0.013	134						5/1/95	

Part 2. No longer burning hazardous waste

227C1	FF	0.001	23	0.4	2.2E+05	6.1E+03		0.04	1/1/94	NLBHW
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CHAPTER 10

TOTAL CHLORINE

Floor levels for total chlorine are discussed below. Note that “total chlorine” stack gas emissions levels are determined as the chlorine equivalent of both HCl and Cl₂ -- calculated as total chlorine (ppmv) = HCl (ppmv) + (2 * Cl₂ (ppmv)).

10.1 INCINERATORS

Table 10-1 summarizes HCl and Cl₂ test condition emissions data from HWIs. The data are ranked by chlorine hazardous waste feedrate MTEC levels, and separated into three sections -- (1) those that use the MACT floor APCS of wet scrubbing; (2) those that do not use the MACT floor APCS of wet scrubbing; and (3) those that are no longer burning hazardous waste. The data are from over 60 different sources.

The incinerator chlorine data are the result of some similar but different stack gas sampling methods, as shown in the far right columns in Table 10-1. This affects how the data are handled:

- The newer data are taken from Method 26, with both HCl and Cl₂ measurements. The Method 26 sampling train has two sets of impinger with different absorbing solutions. The first contains an acidic (H₂SO₄) solution which, in principle, captures HCl only. Cl₂ gas passes through this impinger and is caught in the next impinger containing a basic NaOH solution. The H₂SO₄ and NaOH solutions are analyzed for Cl⁻ ions using ion chromatography (IC). In a recent method update, sodium thiosulfate is added to the NaOH solution to preserve the captured Cl and to convert some of the Cl₂ that is caught and absorbed as hypochlorous acid.
- Much of the “older” data (before 1992 or so) are taken from stack gas sampling trains that are identical to the current Method 26 except they only used impingers with NaOH solution for capturing HCl (did not contain an upfront acidic H₂SO₄ impinger for selectively taking

out HCl as in current Method 26). However, this basic solution will also just as readily capture Cl₂, as it is designed to do in the current Method 26. Potentially, this older data may be biased slightly low because part of the captured Cl₂ may not be detected in the analytical IC method. As discussed above, a portion of the Cl₂ that is caught in the impinger solution may be found as a hypohalous acid that is not detected in the analytical IC method without the use of the sodium thiosulfate. However, this bias is not considered to be important:

- Table 10-2 compares chlorine emissions data from a HWI taken simultaneously with both the old Method (designed for measuring HCl only using impingers with NaOH) and the new Method 26. For the total chlorine measurement, they provide similar results. For the four conditions with higher chlorine emissions levels, the total chlorine measurements agree to within $\pm 25\%$ (i.e., there is no apparent consistent low bias for the old Method for this case). Also, the old Method using NaOH only is certainly recording more than just HCl because: (1) in each of the five different conditions, the old Method levels are much higher than the Method 26 HCl only breakdown; and (2) in two of the conditions, the old Method chlorine is the same or higher than the combined total chlorine level of Method 26.
- The Cl₂ contribution to the total chlorine level is generally only important at lower total chlorine levels. Figure 10-1 shows simultaneous measurements of HCl and Cl₂ from incinerator wet scrubber systems. Cl₂ is usually less than 10% of the HCl level. At higher total chlorine levels resulting from uncontrolled or poorly controlled operations, HCl is preferred over Cl₂. However, at lower HCl levels which are usually the result of the highly efficient wet or dry scrubbing of HCl, Cl₂ levels may be more comparable to HCl because Cl₂ is not as easily controlled as HCl.

Thus, these data are considered as consisting of “total chlorine” -- HCl + Cl₂. Note that, in the proposed rule and May 1997 NODA reanalysis, these data were inappropriately considered as consisting of only HCl. Imputation for Cl₂ was used.

- A few of the data are from sampling trains using impingers containing water only. These data, which usually have very low reported HCl levels, are not considered for setting the total chlorine MACT floor.

For chlorine control, almost all HWIs use some type of flue gas wet scrubbing APCD in combination with chlorine hazardous waste feedrate control to meet the current RCRA standard of either greater than 99% control of chlorine or less than 4 lb/hr HCl emissions. Wet scrubbing devices include venturi-types, packed towers, spray towers, ionizing wet scrubbers, and free-jet and hydro-sonic scrubbers. A couple of facilities use dry or semi-dry scrubbing either by themselves or in combination with wet scrubbing. A couple of facilities do not use any add-on chlorine gas control systems, instead relying entirely on hazardous waste chlorine feedrate to control emissions.

Also of importance for effective total chlorine control is the limitation of the formation of Cl_2 . This is done by forcing chlorine to exist as HCl. HCl is much more easily removed in wet scrubbers compared with Cl_2 . This low Cl_2 condition is achieved in most hazardous waste incinerators through (Ullrich, 1998):

- Provision of fuel/waste hydrogen -- When sufficient levels of hydrogen are provided, the hydrogen preferentially reacts with chlorine as HCl. Ullrich (1998) recommends that, for most efficient conversion to HCl (to minimize Cl_2), a H:Cl stoichiometric molar ratio of 2:1 or greater needs to be maintained. This can be done through provision of supplemental fossil fuel (natural gas, fuel oil, etc.) or the use of steam injection.
- Minimize excess air -- High oxygen levels promote Cl_2 formation. Low excess air is, therefore, important and can be accomplished through minimizing air leaks and operating as close to stoichiometric as possible.
- Rapid gas quenching -- At high temperatures, HCl is thermodynamically favored (Cl_2 levels are very low). Rapid combustion flue gas quenching is preferred to freeze the high temperature HCl/ Cl_2 equilibrium ratio, which is very large. For slow gas quenching systems, higher levels of Cl_2 may be formed at lower temperature HCl/ Cl_2 equilibrium gas conditions.

HCl is easily captured and removed in wet scrubbers. Cl_2 gas can be controlled to some more limited degree in wet scrubbers, but at much more expense (Ullrich, 1998). Cl_2 gas control in wet scrubbers involves operation of the scrubber with a pH basic scrubbing solution ($\text{pH} > 7$). Typical Cl_2 removal efficiency as a function of scrubber pH is shown in Figure 10-2. Capture of Cl_2 in high pH scrubber liquids can be difficult: (1) at high pHs, CO_2 can begin to be scrubbed out, making the alkali sorbent requirements very high; (2) pH is difficult to accurately control when inlet chlorine loading varies; (3) the presence of calcium will lead to solids formation and system

plugging; and (4) captured chlorine is turned to bleach in the scrubber liquid, which needs to be further reacted to salt prior to scrubber liquor disposal. One recommended set-up for systems requiring significant Cl_2 gas control is the use of a two-scrubber system, which is common on many existing hazardous waste incinerators. The first scrubber is operated with an acidic scrubber solution, removing the majority of the HCl. The second downstream scrubber with low acid gas load, is operated in a narrow pH basic scrubber solution range.

10.1.1 Existing Sources Floor

The best performers based on emissions levels use wet scrubbing and chlorine feedrate control. The best performers based on SREs, as shown in Table 10-1 and Figure 10-3, use wet scrubbers, as would be expected based on engineering information and principles. SREs of greater than 99% (the current RCRA requirement for HCl) are consistently achieved, with most greater than 99.9% and some greater than 99.99%.

Based on the performance of the best performing 6% of sources, MACT for chlorine for incinerators is defined as both: (1) the use of a well operated and designed wet scrubbing system achieving a chlorine SRE of greater than 99%; and (2) chlorine feedrate control to a level determined by the Aggregate Feedrate method discussed in Chapter 6. There is no attempt to define the scrubber type and what constitutes proper design and operation because of the many different types and configurations of scrubber systems, as well as the general lack of comprehensive design and operating data that would be required to accurately define each type. Instead, a scrubber efficiency of 99% is determined to be representative of MACT control, based on current RCRA requirements and existing wet scrubber chlorine SREs, shown in Figure 10-3.

The incinerator chlorine MACT defining hazardous waste feedrate is set at 2.2×10^7 $\mu\text{g/dscm}$, based on that identified by the Aggregate Feedrate method discussed in Chapter 6. Note that chlorine hazardous waste feedrate MTECs range very widely from 100,000 to 2.0×10^8 $\mu\text{g/dscm}$. More than half of all of the feedrates from facilities using wet scrubbers and currently operating are less than the MACT defining level of 2.2×10^7 $\mu\text{g/dscm}$.

The incinerator total chlorine MACT floor standard is set at 77 ppmv (Source ID No. 714C1). This is the highest testing condition with a chlorine hazardous waste feedrate MTEC less than the MACT defining level and achieving a chlorine SRE of greater than 99%. The floor of 77 ppmv is generally consistent with a 99% chlorine control applied to a feedrate MTEC of 2.2×10^7 $\mu\text{g/dscm}$. This feedrate MTEC level translates to a total chlorine emissions level of about 100 ppmv based on 99% chlorine control.

There are a couple of facilities that use wet scrubbers and have chlorine feedrate MTECs less than the MACT defining level but have chlorine emissions greater than the floor of 77 ppmv. These are not considered for setting the MACT floor due to non-MACT like wet scrubber performance, based on chlorine SREs less than 99%. This performance consequently cannot be used to determine levels “achievable in practice” by properly designed and operated wet scrubber technology. These conditions include:

- Source ID No. 714C2 and 714C5, with emissions levels of 86 and 126 ppmv. Both of these conditions are clearly indicated in the test report as not meeting the current RCRA chlorine standards (i.e., SRE less than 99%) and are not used as permit setting conditions. Additionally, three other conditions from this same facility have SREs greater than 99% and stack gas chlorine emissions less than the MACT floor.
- Source ID No. 725C2, with an emissions level of 165 ppmv. This condition is unusual in that the Cl_2 level contributes to over 95% of the total chlorine level (i.e., HCl is very low). With proper supply of hydrogen and rapid gas quenching, Cl_2 gas levels from incinerators are demonstrated to be low. Note that this facility has another condition 725C1 with SRE almost at 99% and emissions of 75 ppmv, which is less than the MACT floor.
- Source ID No. 459C2, with an emissions level of 203 ppmv. The test report clearly indicates that this test condition did not meet current RCRA standards. This is an on-site incinerator that is used for combustion “research” evaluations and is not used for production treatment of wastes. Additionally, there are other units at the site with wet scrubbers that meet the MACT floor.

Note that, during most of the trial burn tests for which emissions data are presented above, chlorine “spiking” has been conducted in order to set desired upper limits on chlorine feedrates. Spiking involves intentionally adding in a known amount of chlorine to the incinerator feedstreams to allow subsequent operations at these chlorine feedrates.

10.1.2 New Sources Floor

MACT for new sources is defined as the use of efficient wet scrubbing (at least 99% chlorine control) and chlorine feedrate control. The incinerator chlorine MACT defining hazardous waste feedrate is set at 4.7×10^6 $\mu\text{g/dscm}$, based on that identified by the Aggregate Feedrate MTEC

method discussed in Chapter 2. The incinerator total chlorine MACT floor standard is set at 21 ppmv (Source ID No. 340C2).

10.2 CEMENT KILNS

Table 10-3 summarizes all total chlorine test condition data from CKs. The table is divided into three sections. The first section contains test conditions from long kilns that do not use in-line raw mills, ranked by hazardous waste feedrate MTEC. The second set contains test conditions from short and/or in-line raw mill kilns. The third section contains conditions from facilities that are no longer burning hazardous waste.

The data are from about 35 different CKs. Stack gas emissions condition averages range widely from 0.1 to 220 ppmv. For all of the CoC test conditions (and almost all of the other normal and research testing evaluations), complete total chlorine data sets with both HCl and Cl₂ measurements are available.

Chlorine emissions in CKs are controlled currently under RCRA BIF risk-based emissions limits directly through hazardous waste feedrate control. No hazardous waste burning CKs currently use a dedicated control device designed specifically to remove chlorine from the flue gas (e.g., wet or dry scrubbers). However, most of the chlorine generated during combustion of chlorine-containing hazardous wastes is neutralized by the highly alkaline particulate resulting from the use of limestone in the cement making process. Chlorine contained in the cement kiln dust is then removed from the stack gas in the PM APCD. In effect, the kiln itself is a dry scrubbing process. As shown in Table 10-3 and Figure 10-4, chlorine SREs in hazardous waste burning CKs (long kilns and combined main/bypass short kilns) range from 60 to 99+%, with most greater than 95%. There is no strong influence of APCD type or wet vs dry type of kiln. Note that it has been suggested that: (1) FFs may be better than ESPs due to increased acid gas absorbing cement kiln dust holdup, build-up, and contacting with the flue gas; (2) wet kilns may be better than dry kilns due to increased flue gas moisture levels leading to more efficient chlorine absorption; and (3) higher control efficiencies may be associated with lower temperature APCD operation. However, the data do not strongly confirm any of these conjectures.

As shown in Figure 10-4, almost all of the CK chlorine SREs are greater than 90%. It is likely that the emissions and feedrate measurements of conditions with lower SREs are not accurate. The level of greater than 90% removal is consistent with what would be expected for dry lime scrubbing systems, similar to that taking place in a cement kiln. However, it is not clear as to why there is such a large range of barely 90 to greater than 99.95% control.

10.2.1 Existing Sources Floor

The MACT floor for existing sources is based on chlorine feedrate control in the hazardous waste. The MACT defining chlorine hazardous waste feedrate MTEC, based on the Aggregate Feedrate analysis of Chapter 6, is 7.2×10^5 $\mu\text{g/dscm}$. The CK total chlorine MACT standard is 130 ppmv, based on Source ID No. 203C5. Note that:

- All but 3 of the total chlorine CK test conditions meet the MACT floor level of 130 ppmv.
- Chlorine hazardous waste MTECs range from 100,000 to 4×10^6 $\mu\text{g/dscm}$. About 30% are less than the MACT floor defining level of 7.2×10^6 .
- The MACT floor level of 130 ppmv is being achieved by the short and in-line raw mill kilns:
 - Of the two short preheater/precalciner in-line raw mill kilns, ID No. 321 has multiple conditions of both individual main stack and bypass stack levels of less than 5 ppmv. ID No. 303 has combined bypass/main stack levels at 10 and 82 ppmv
 - The long kiln with an in-line raw mill (ID No. 202) has levels at 2 and 31 ppmv, with and without the in-line raw mill in operation.

Also note that:

- For all of the kilns with in-line raw mills, chlorine emissions are lower when the in-line raw mill is operating, as is expected from theoretical considerations. However, chlorine emissions for all conditions, regardless of the status of the in-line raw mill, are well below the floor of 130 ppmv.
- For short kiln bypasses, like SVMs, chlorine salts may tend to concentrate in the bypass off-gas, implying that bypass chlorine levels should be higher than main stack levels. However, for three kilns where simultaneous data are available from both stacks, the bypass HCl/Cl₂ concentrations are both higher and lower than main stack concentrations.

- Short kilns have generally higher SREs and lower emissions levels compared with long kilns.
- The floor level of 130 ppmv is being achieved by the one low-alkali cement producing hazardous waste burning cement kiln (Source ID No. 320, Lafarge, Alpena). Data for No. 320 are available from 7 different test conditions, as shown in Table 10-4. Emissions levels are all less than 83 ppmv, with all but one less than 34 ppmv. Commenters have argued that low alkali kilns have higher chlorine stack gas emissions levels and cannot meet the floor. However, chlorine is clearly being controlled in low-alkali kilns, due to the abundance of calcium-containing limestone, as well as the capture of alkali-chlorides as CKD in the PM APCD.

10.2.2 New Sources Floor

MACT floor control for new sources is chlorine feedrate control of the hazardous waste. The MACT defining chlorine hazardous waste feedrate MTEC, based on the Aggregate Feedrate analysis of Chapter 6, is 4.5×10^5 $\mu\text{g/dscm}$. The CK total chlorine MACT floor is 86 ppmv.

10.3 LIGHTWEIGHT AGGREGATE KILNS

Table 10-5 summarizes all total chlorine test condition data from LWAKs. The table is broken into two sections. The first section has data from kilns burning hazardous waste. Test conditions are ranked by chlorine hazardous waste feedrate MTEC. The second section contains data from the one facility that is no longer burning hazardous waste.

The data are from 15 different LWAKs. Stack gas emissions test condition averages range widely from 13 to 2,100 ppmv. Complete data sets for HCl and Cl_2 are available for all of the conditions.

Chlorine emissions in LWAKs are controlled currently under RCRA BIF risk-based emissions limits directly through hazardous waste feedrate control and/or add-on dry and wet scrubbers:

- Feedrate control only -- All but three of the kilns rely solely on hazardous waste chlorine feedrate control. These LWAKs have no inherent or add-on chlorine control capabilities. LWAKs, unlike cement kilns, do not use process materials that have chlorine control capabilities. FFs by themselves provide no chlorine control. Accordingly, for these kilns,

chlorine SREs are around zero. Note that Source ID No. 224C1 is apparently achieving 95% control. This is due to either the use of dry lime scrubbing or errors in feedrate or emissions rate measurements.

- Wet scrubbing -- Two kilns (Norlite kilns, Source ID Nos. 307 and 479) use wet scrubbers (venturi-type) for the control of chlorine. Source ID No. 307 is consistently achieving greater than 98% chlorine control.
- Dry scrubbing -- Dry lime-based scrubbing systems for chlorine control are currently on the Solite North Carolina and Kentucky facilities (Source ID Nos. 225 and 226, ID No. 475 for 1994 testing only). However, control efficiency is unclear due to conflicting trial burn results. Some conditions supposedly using dry scrubbing are not achieving any noticeable chlorine control. Dry scrubbing should achieve better than 90% control of chlorine. For other LWAKs which use FFs without dry scrubbing, feedrate control is the chlorine control method.

The best performing sources use either a combination of feedrate control and wet scrubbing (venturi) or feedrate control alone for chlorine control.

10.3.1 Existing Sources Floor

MACT floor control for existing source LWAKs is based on the best performing 3 sources. Two kilns (the two Norlite kilns both located at the same facility site) use wet scrubbing. The rest use feedrate control only. Thus, MACT for chlorine control is defined as feedrate control only for existing sources. The MACT defining chlorine hazardous waste feedrate, from the Aggregate Feedrate MTEC approach of Chapter 6, is 2.0×10^6 $\mu\text{g}/\text{dscm}$. About 75% of all LWAK chlorine MTECs are less than this level. The LWAK total chlorine MACT floor is set at 1500 ppmv, based on Source ID No. 225C1. Almost all other total chlorine stack gas emissions are lower than the MACT floor level.

10.3.2 Existing Sources Beyond the Floor

A total chlorine beyond the floor level of 230 ppmv is determined to be cost effective for LWAKs. The beyond the floor level is based on the use of dry scrubbing with simple duct injection to achieve 85% chlorine control. This level of control has been demonstrated in recent EPA testing of simple duct injection of hydrated lime at a hazardous waste burning LWAK at an operating lime to acid gas stoichiometric ratio of 3:1. Additionally, the beyond the floor level of

230 ppmv is reasonable because: (1) many LWAKs already emit HCl/Cl₂ at levels below the floor of 1500 ppmv, which means these sources may not need to achieve a 85% efficiency to meet the beyond the floor level; and (2) LWAKs operate day-to-day at chlorine feedrate levels well below the levels shown during compliance testing because sources generally spiked worst case expected levels of chlorine. Again, an efficiency of 85% would not be needed to achieve the BTF standard.

See Chapter 14 for a detailed discussion of the basis of the beyond the floor control, as well as other chlorine control options and effectiveness. Higher levels of control, although achievable through alternative control methods, are not determined to be cost effective.

10.3.3 New Sources Floor

MACT for new sources is based on the best performing source, which uses chlorine control in the hazardous waste and wet scrubbing (Source ID Nos. 307). Stack gas chlorine emissions from this source are much lower than those from any of the other LWAKs, which use only feedrate control and not wet scrubbing. Chlorine system removal efficiencies for the wet scrubbers are greater than 99%, which is indicative of good system performance. This source has four different test conditions. The floor level is set, based on the highest emitting condition average from the kilns using wet scrubbing, at 41 µg/dscm.

Note that the data set used to base the standard on is fairly small, containing just 4 test conditions. However, as shown in Figure 10-5, the highest test condition average is used, as opposed to the highest individual run, because: (1) all but one of the individual runs are less than 41 ppmv; and (2) the highest individual run of the highest test condition at 90 ppmv appears to be an outlier.

Additionally, note that the MACT defining MTEC from the Aggregate Feedrate approach of Chapter 6 is not used to set the chlorine MACT floor for new sources for LWAKs. The Aggregate Feedrate approach is based on all hazardous waste burning LWAKs. Except for ID Nos. 307 and 479 which use wet scrubbers, LWAKs do not use any chlorine APCD, instead controlling chlorine emissions through feedrate control alone.

Considering all LWAK stack gas chlorine emissions, Source ID No. 307, which uses wet scrubbing, is clearly the best performing source (i.e., it has the lowest emissions levels, less than 10 times the emissions of most other kilns). This is the case even though it fed chlorine at a level 10 times higher than any of the other kilns. Low emissions are due to the use of a wet scrubber with a chlorine SRE of greater than 99%. Whereas for all of the other LWAKs, chlorine was not

effectively being controlled (0% SREs for the most part). Thus, setting the MACT floor based on the Aggregate Feedrate approach is not appropriate. This is because wet scrubbing is clearly MACT for new sources, and there are no conditions from the wet scrubbing kiln ID No. 307 with chlorine feedrates at or less than that produced from the Aggregate Feedrate approach.

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
Part 1. Use MACT APCS (wet scrubbers)											
613C2	WHB/Q/S/PBS	0.3	100			1.0E+05		99.61			DI H2O
347C1	C/QT/VS/PBS/DM	0	100			1.1E+05		99.46		EPA 26	
711C2	C/WHB/VS/AS	1				1.5E+05		99.21			
504C1	VS/C	5	0.5		3.73E+03	1.5E+05	5	95.02			
613C1	WHB/Q/S/PBS	0.2	100			1.5E+05		99.78			DI H2O
613C3	WHB/Q/S/PBS	0.2	100			1.6E+05		99.79			DI H2O
711C3	C/WHB/VS/AS	1				7.8E+05		99.82		EPA 5	Na2CO3
711C1	C/WHB/VS/AS	1				9.1E+05		99.88			
806C1	C/VS	39				1.0E+06		94.23			
806C2	C/VS	48			7.69E+02	1.3E+06		94.53			
701C2	VS/PT	1				1.4E+06		99.88			
480C3	QC/HS	3		x		1.4E+06		99.71			
613C4	WHB/Q/S/PBS	0.2	100			1.5E+06		99.98			DI H2O
480C2	QC/HS	2		x		1.5E+06		99.83			
700C2	SD/RJS/VS/WS	4	2	x	3.14E+03	1.7E+06		99.64		EPA 26	
347C3	C/QT/VS/PBS/DM	2	5			1.8E+06		99.80			
613C5	WHB/Q/S/PBS	0.2	100			2.0E+06		99.99			DI H2O
701C3	VS/PT	7				2.3E+06		99.56			
705C2	QT/VS/PT/WESP	12				2.6E+06		99.31			
805C1	QT/QS/VS/ES/PBS	10				2.8E+06		99.47			
700C1	SD/RJS/VS/WS	29		x	4.72E+03	3.1E+06		98.61		EPA 26	
609C1	SS/PT/VS/DM	1		x		3.2E+06		99.95			
495C2	WHB/ESP/Q/S	1	100			3.3E+06		99.94			
495C1	WHB/ESP/Q/S	1	100			3.4E+06		99.93			
353C1	QC/VS/DM/WESP	4	68			3.6E+06		99.84		EPA 26	
340C2	WHB/ESP/WS	21				3.6E+06		99.12			
490C1	SS/PBS	0.2		x		3.6E+06		99.99			
490C2	SS/PBS	0.3		x		3.7E+06		99.99		EPA 26	
338C1	QC/FF/SS/C/HES/DM	0.1	83	x		3.8E+06		99.99	Nor		
334C1	WHB/Q/WS/WESP/PT/	12				4.0E+06		99.56		EPA 5	NaOH
222B3	WHB/SD/CI/ESP/Q/PB:	1	27	x		4.0E+06		99.98		EPA 26	

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
603C4	QT/S/IWS	1				4.1E+06	2	99.95			
603C3	QT/S/IWS	1				4.1E+06		99.96			
603C5	QT/S/IWS	0.01	100			4.1E+06		100.00		EPA 26	H2SO4, NaOH
495C3	WHB/ESP/Q/S	1	100			4.2E+06		99.95			
342C2	WHB/QC/S/VS/DM	0.2				4.4E+06		99.99		EPA 26	H2SO4, NaOH
906C2	QT/PT	59		x		4.4E+06		98.01		EPA 26	
477C1	QT/PT/VS/DM	5	100			4.4E+06		99.83		EPA 5	NaOH
340C1	WHB/ESP/WS	13				4.6E+06		99.56			
603C8	QT/S/IWS	0.2	77		2.01E+04	4.7E+06		99.99		EPA 5	NaOH
824C1	QT/VS/PT/DM	2				4.9E+06		99.93		EPA 13	NaOH, acid H2C
603C2	QT/S/IWS	0.4			3.32E+03	5.1E+06		99.99		EPA 5	NaOH
707C1	OS/QC/WS	2				5.3E+06		99.95			
477C2	QT/PT/VS/DM	5	100			5.4E+06		99.86	1 run	EPA 5	NaOH
359C6	WHB/FF/S	31				6.3E+06		99.27			
725C1	WS/QT	75		x		6.3E+06		98.21		EPA 26	
725C2	WS/QT	165		x		6.3E+06		96.10		EPA 26	
707C2	OS/QC/WS	7				6.5E+06		99.83			
707C7	OS/QC/WS	2				6.5E+06		99.95			
707C3	OS/QC/WS	8				6.6E+06		99.82		EPA 5	NaOH
338C2	QC/FF/SS/C/HES/DM	0.1	100	x		6.6E+06		100.00			
707C4	OS/QC/WS	11				6.9E+06		99.76		EPA 5	NaOH
707A1	OS/QC/WS	7				7.2E+06		99.86			
465C1	QT/S	1				7.2E+06		99.97		EPA 5	
707C8	OS/QC/WS	4				7.5E+06		99.91			
454C1	VQ/PT/CT/WESP	51				7.6E+06		99.00			
706C1	QT/HS/C/DM	0.3	23			7.7E+06		99.99		EPA 5	NaOH
359C5	WHB/FF/S	5				7.8E+06		99.90		EPA 26	NaOH
915C3	QC/VS/C	9		x		8.0E+06		99.84			
359C4	WHB/FF/S	4				8.1E+06		99.93		EPA 26	NaOH
468C1	Q/VS	22				8.1E+06		99.59		EPA 6	KOH
707C9	OS/QC/WS	7				8.2E+06		99.87		EPA 5	NaOH
705C1	QT/VS/PT/WESP	21				8.2E+06		99.61			
465C2	QT/S	1				8.4E+06		99.99		EPA 5	

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
706C3	QT/HS/C/DM	0.2	100			8.5E+06		100.00		EPA 5	NaOH
706C2	QT/HS/C/DM	1	8			8.5E+06		99.99			
488C1	SS/PT/VS/DM	8	100	x		8.8E+06		99.87		EPA 26	
915C2	QC/VS/C	20		x		8.9E+06		99.66			
714C3	PBS	42				9.1E+06		99.30			
334C2	WHB/Q/WS/WESP/PT/	20				9.1E+06		99.67		EPA 5	NaOH
603C7	QT/S/IWS	0.4			1.58E+04	9.3E+06		99.99		EPA 5	NaOH
714C2	PBS	86				9.9E+06		98.69			
602C2	Q/S/C/DM/HEPA	2		x	5.18E+03	1.0E+07	0.3	99.97		EPA 26	
714C4	PBS	12				1.0E+07		99.81		EPA 5	NaOH
463C1	QT/VS/S	33				1.0E+07		99.51		EPA 5	KOH
459C1	S	203				1.0E+07		97.05			
209C3	WHB/FF/VQ/PT/DM	33				1.0E+07		99.52			
357C1	QC/VS/PT/IWS	7	22			1.0E+07	0.4	99.90		EPA 5	
602C1	Q/S/C/DM/HEPA	1		x	1.21E+04	1.1E+07	0.3	99.98		EPA 26	
915C1	QC/VS/C	26		x		1.1E+07		99.65			
209C4	WHB/FF/VQ/PT/DM	2	93			1.1E+07		99.97		EPA 5	NaOH
358C2	QC/VS/C/CT/S/DM	0.2	100			1.1E+07		100.00		EPA 5	NaOH
603B3	QT/S/IWS	0.3		x		1.2E+07		100.00		EPA 26	
603B1	QT/S/IWS	8			1.51E+04	1.2E+07		99.90		EPA 5	
602C3	Q/S/C/DM/HEPA	1		x	7.80E+03	1.2E+07	0.2	99.99		EPA 26	
603C6	QT/S/IWS	0.2	100		5.18E+04	1.3E+07	0.1	100.00		EPA 5	NaOH
714C1	PBS	77				1.3E+07		99.09			
714C5	PBS	126				1.3E+07		98.59			
354C3	QC/AS/VS/DM/IWS	0.4		x		1.4E+07		100.00		EPA 26	
707A2	OS/QC/WS	3				1.5E+07		99.97		EPA 5	NaOH
210C2	SD/FF/PT	54		x		1.5E+07		99.46		EPA 26	
603C1	QT/S/IWS	1	57		1.29E+03	1.5E+07		99.99		EPA 5	NaOH
488C2	SS/PT/VS/DM	6	78	x		1.6E+07		99.95		EPA 26	
359C3	WHB/FF/S	2				1.6E+07		99.98		EPA 5	NaOH
489C1	SS/PT/VS/DM	8	100	x		1.6E+07		99.93		EPA 26	
601C2	WHB/DS/FF/WS	7		x		1.7E+07		99.94		EPA 26	
603C9	QT/S/IWS	2				1.8E+07		99.98		EPA 5	NaOH

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
601C3	WHB/DS/FF/WS	1		x		1.8E+07		99.99		EPA 26	
480C1	QC/HS	4		x		1.8E+07		99.96			
728C1	QT/PT/VS	0.4	3			1.8E+07		100.00		EPA 5	NaOH
601C1	WHB/DS/FF/WS	1		x		1.9E+07		99.99		EPA 26	
331C2	Q/PT/IWS/DM	0.5	49			1.9E+07		100.00		1992	
331C3	Q/PT/IWS/DM	0.4	100			1.9E+07		100.00		1992	
222C3	WHB/SD/CI/ESP/Q/PB	2	2	x		2.0E+07		99.99		EPA 26	
210C1	SD/FF/PT	16	2	x		2.0E+07		99.88		EPA 26	
808C2	QT/PBS/WESP	0.3				2.1E+07		100.00		EPA 5	Na2CO3
325C5	SD/FF/WS/IWS	3				2.2E+07		99.98		EPA 5	
327C3	SD/FF/WS/WESP	2	4	x		2.2E+07		99.99		EPA 26	
327C1	SD/FF/WS/WESP	9		x		2.2E+07		99.94		EPA 26	
331C7	Q/PT/IWS/DM	18				2.3E+07		99.88			
359C1	WHB/FF/S	3				2.3E+07		99.98		EPA 5	NaOH
222C1	WHB/SD/CI/ESP/Q/PB	0.3	35	x		2.3E+07		100.00		EPA 26	
331C8	Q/PT/IWS/DM	6				2.3E+07		99.96			
327C2	SD/FF/WS/WESP	1	36	x		2.4E+07		99.99		EPA 26	
325C4	SD/FF/WS/IWS	1				2.4E+07		99.99		EPA 5	
325C6	SD/FF/WS/IWS	6				2.4E+07		99.96			
222C2	WHB/SD/CI/ESP/Q/PB	4		x		2.4E+07		99.98			
214C1	Q/IWS	2	100			2.4E+07		99.99		ModEPA 6	
221C1	SS/PT/VS	10	29	x		2.5E+07		99.94		EPA 26	
359C2	WHB/FF/S	2				2.5E+07		99.99		EPA 5	NaOH
808C1	QT/PBS/WESP	1				2.6E+07		100.00		EPA 5	Na2CO3
211C1	SD/FF/PT	38		x		2.6E+07		99.78		EPA 26	
331C9	Q/PT/IWS/DM	3				2.6E+07		99.98			
331C5	Q/PT/IWS/DM	13				2.7E+07		99.93			
209C5	WHB/FF/VQ/PT/DM	4				2.7E+07		99.98		EPA 5	NaOH
465C3	QT/S	2				2.8E+07		99.99		EPA 5	
214C2	Q/IWS	2				2.8E+07		99.99		EPA 6	NaOH
458C1	VS/PT/QT	5				2.8E+07		99.97		EPA 5	NaC2H3O2
222C6	WHB/SD/CI/ESP/Q/PB	2	2	x		2.8E+07		99.99		EPA 26	
214C3	Q/IWS	1				2.9E+07		100.00		EPA 6	NaOH

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
221C4	SS/PT/VS	35		x		2.9E+07		99.82		EPA 26	
701C1	VS/PT	26				3.1E+07		99.87			
600C1	WHB/QC/PT/IWS	0.5				3.1E+07		100.00		EPA 5	
221C2	SS/PT/VS	9	27	x		3.1E+07		99.96		EPA 26	
354C2	QC/AS/VS/DM/IWS	2		x		3.1E+07		99.99		EPA 26	
221C3	SS/PT/VS	15	8	x		3.1E+07		99.93		EPA 26	
325C7	SD/FF/WS/IWS	36				3.1E+07		99.83		EPA 5	
331C4	Q/PT/IWS/DM	17				3.2E+07		99.92			
331C6	Q/PT/IWS/DM	6				3.2E+07		99.97			
221C5	SS/PT/VS	144		x		3.3E+07		99.35		EPA 26	
212C1	SD/FF/PT	134	0.05	x		3.3E+07		99.40		EPA 26	
209C7	WHB/FF/VQ/PT/DM	4				3.4E+07		99.98		EPA 5	NaOH
488C3	SS/PT/VS/DM	122		x		3.4E+07		99.46		EPA 26	
825C1	CCS/QC/WESP	4				3.5E+07		99.98		EPA 5	KOH
209C6	WHB/FF/VQ/PT/DM	5				3.6E+07		99.98		EPA 5	NaOH
209C1	WHB/FF/VQ/PT/DM	16	0.1	x		3.8E+07		99.94		EPA 26	
484C3	WHB/QT/VS/DM	158				3.9E+07		99.39		EPA 5	NaOH
348C4	QC/AS/IWS	1	19	x		3.9E+07		100.00		EPA 26	
209C2	WHB/FF/VQ/PT/DM	105		x		4.0E+07		99.61		EPA 26	
358C3	QC/VS/C/CT/S/DM	1				4.2E+07		100.00		EPA 5	NaOH
358C4	QC/VS/C/CT/S/DM	8				4.4E+07		99.97		EPA 5	NaOH
354C1	QC/AS/VS/DM/IWS	8		x		4.4E+07		99.97		EPA 26	
358C1	QC/VS/C/CT/S/DM	4	2			4.8E+07		99.99		EPA 5	NaOH
209C8	WHB/FF/VQ/PT/DM	4				4.8E+07		99.99		EPA 5	NaOH
600C2	WHB/QC/PT/IWS	2				4.9E+07		100.00		EPA 5	
906C3	QT/PT	347		x		5.2E+07		99.00	Nor	EPA 26	
708C3	VS/PT/WESP	1				5.5E+07	0.4	100.00		EPA 5	H2SO4, NaOH
906C1	QT/PT	1639		x		5.6E+07		95.58	Nor, Fail RCRA Stnd	EPA 26	
353C2	QC/VS/DM/WESP	27				6.3E+07		99.94		EPA 26	
906C4	QT/PT	549		x		6.5E+07		98.73	Fail RCRA Stnd	EPA 26	
708C2	VS/PT/WESP	1				7.0E+07	0.4	100.00		EPA 5	H2SO4, NaOH
348C3	QC/AS/IWS	1		x	1.62E+03	7.4E+07		100.00		EPA 26	
906C5	QT/PT	873		x		7.7E+07		98.29	Fail RCRA Stnd	EPA 26	

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
458C2	VS/PT/QT	43				9.5E+07		99.93		EPA 5	NaC2H3O2
348C1	QC/AS/IWS	1	6	x	7.01E+02	1.0E+08		100.00	Nor	EPA 26	
610C1	S	65		x		1.0E+08		99.90		EPA 26	
348C2	QC/AS/IWS	3		x	3.63E+03	1.1E+08	4	100.00		EPA 26	
708C1	VS/PT/WESP	2				1.4E+08	0.4	100.00		EPA 5	H2SO4, NaOH
229C1	WHB/ACS/HCS/CS	93				1.6E+08		99.91		EPA 26	H2SO4, NaOH
229C2	WHB/ACS/HCS/CS	176				1.8E+08		99.86		EPA 26	H2SO4, NaOH
229C4	WHB/ACS/HCS/CS	134				1.9E+08		99.89		EPA 26	H2SO4, NaOH
229C3	WHB/ACS/HCS/CS	5				1.9E+08		100.00		EPA 26	H2SO4, NaOH
229C6	WHB/ACS/HCS/CS	49				2.1E+08		99.97		EPA 26	H2SO4, NaOH
603B2	QT/S/IWS	13			1.20E+05	2.4E+08		99.99		EPA 5	
229C5	WHB/ACS/HCS/CS	80				2.4E+08		99.95		EPA 26	H2SO4, NaOH
347C2	C/QT/VS/PBS/DM	0.1	100					NA	B, 1 run		
605C1	WS	0.4						NA	Nor		
347C8	C/QT/VS/PBS/DM	0.8	100					NA			
493C1	C/QT/VS/PBS/DM	1	83					NA			
494C1	C/QT/VS/PBS/DM	1	52					NA			
486C1	VQ/C/PT/ES	1		x				NA			
354C4	QC/AS/VS/DM/IWS	1		x				NA			
344C3	QC/VS/PT/DM	0.4	41					NA			
614C3	S	1						NA	Nor		
614C2	S	1						NA	Nor		
470C1	QT/VS/PBS/DM	1	16					NA			
334C3	WHB/Q/WS/WESP/PT/	3						NA	Nor		
346C1	C/QC/VS/PT/DM	1	100					NA			
347C4	C/QT/VS/PBS/DM	4						NA	B, 1 run		
614C1	S	3						NA	Nor		
216C7	HES/WS	9						NA			
216C2	HES/WS	10						NA			
344C1	QC/VS/PT/DM	1	100					NA			
325C8	SD/FF/WS/IWS	2						NA			
344C2	QC/VS/PT/DM	1	100					NA			
611C1	WS	138		x				NA	Poor WS oper, Nor	EPA 26	

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
606C2	WHB/S	183		x				NA	Poor WS operation		
606C1	WHB/S	382		x				NA	Poor WS operation		

Part 2. Do not use MACT APCS (wet scrubbers)

904C5	WHB	0.2		x		4.9E-01	100	-48420	Low MTEC, MB	EPA 26	
904C4	WHB	0.4		x		5.2E-01	100	-106049	Low MTEC, MB	EPA 26	
337C2	WHB/DA/DI/FF	0.3	100			9.6E+04		99.46	Dry scrubbing		
324C6	WHB	36				1.2E+05		53.58	No WS		
784C2	NONE	912				1.2E+05		-1076.56	No WS		
784C1	NONE	876				1.3E+05		-940.20	No WS		
337C1	WHB/DA/DI/FF	10				1.3E+05		88.30	No WS		
324C2	WHB	146				1.4E+05		-58.68	No WS		
324C7	WHB	55				1.5E+05		42.98	No WS		
324C5	WHB	61				1.9E+05		52.74	No WS		
324C3	WHB	165				2.0E+05		-22.89	No WS		
324C4	WHB	170				2.2E+05		NA	No WS		
324C1	WHB	168				2.2E+05		-13.29	No WS		
453C1	WHB	220	100			3.4E+05	12	3	No APCD		
704C3	WHB	14				3.4E+05		94.09	No WS		
1001C5	HE/FF	64		x		7.8E+05		87.76	No WS or DS	EPA 26	
341C2	DA/DI/FF/HEPA/CA	4				2.3E+06		99.73	Dry scrubbing		
341C1	DA/DI/FF/HEPA/CA	15				5.0E+06		99.54	Dry scrubbing		
333C1	SD/FF	50		x		8.8E+06		99.15	Spray dry scrubbing	EPA 26	
333C2	SD/FF	61	0.04	x		1.3E+07		99.33	Spray dry scrubbing	EPA 26	
612C1	SD/FF	16		x		1.4E+07		99.83	No WS	EPA 26	
704C1	WHB	144				9.5E+07	0.1	99.77	No APCD		
704C2	WHB	181				1.1E+08		99.76	No APCD		
505C4	WHB	1						NA	No WS		
505C2	WHB	2						NA	No WS		
505C3	WHB	2	7					NA	No WS		
505C1	WHB	3						NA	No WS		
464C1	NONE	12						NA	No WS		

TABLE 10-1. INCINERATOR TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss			CI MTEC (µg/dscm)			SRE (%)	Summary Comments	Sampling Method	
		Stack (ppmv)	ND (%)	HCl & Cl ₂	Other	HW	ND (%)			Meth No.	Impinger Solutions
471C1	QT/FF	59						NA	No WS		
457C1	NONE	4224						NA	No WS		

Part 3. No longer burning hazardous waste

713C1	VS/PT	25			7.36E-01	3.2E+06		98.81	NLBHW		
903C1	VS/PT/CA/HEPA	1		x		3.5E+05		99.44	NLBHW		
500C1	QC/VS/KOV/DM	15		x		2.9E+06		99.21	NLBHW		
807C1	C/WHB/VQ/PT/HS/DM	2		x		7.6E+06		99.97	NLBHW		
807C2	C/WHB/VQ/PT/HS/DM	3		x		8.7E+06		99.94	NLBHW		
807C3	C/WHB/VQ/PT/HS/DM	3		x		9.0E+06		99.94	NLBHW		
502C1	WHB/QC/PBC/VS/ES	19				9.7E+06		99.71	NLBHW	EPA 26	
500C2	QC/VS/KOV/DM	67		x		1.3E+07		99.20	NLBHW		
500C4	QC/VS/KOV/DM	1				1.5E+07		99.99	NLBHW	EPA 5	
500C3	QC/VS/KOV/DM	2		x		1.8E+07		99.98	NLBHW		
329C1	PT/IWS	8	8	x		2.0E+07		99.94	NLBHW		
462C1	S	78				2.2E+07		99.47	NLBHW		
330C1	QT/PBS/DM	51				2.6E+07		99.70	NLBHW		
462C2	S	98				2.8E+07		99.48	NLBHW		
339C1	AT/PT/RJS/WESP	20		x		3.6E+07		99.92	NLBHW		
332C1	HES	33				3.9E+07		99.87	NLBHW	EPA 5	NaOH
902C1	QT/VS/PT	4				3.9E+07		99.98	NLBHW	EPA 5	H2SO4, NaOH
710C4	QT/OS/C/S	203	0.2	x		4.5E+07		99.33	NLBHW		
710C3	QT/OS/C/S	347		x		4.5E+07		98.85	NLBHW		
710C2	QT/OS/C/S	439		x		4.9E+07		98.66	NLBHW		
356C3	QC/AS/FN/PBS/DM	468				5.4E+07		98.69	NLBHW		
710C1	QT/OS/C/S	356		x		6.5E+07		99.18	NLBHW		
703C2	WHB	316				5.2E+05		8.77	NLBHW, No APCD		
703C1	WHB	270				5.7E+05		29.73	NLBHW, No APCD		
400C1	SD/FF	1893		x	1.73E+07	1.3E+06		-116.06	NLBHW		
914C1	?	19				1.7E+07		99.84	NLBHW, ? APCD	EPA 26	

TABLE 10-2. CHLORINE MEASUREMENT METHOD COMPARISON

Chlorine Feed/Emissions	Condition ID No.				
	C1	C2	C3	C4	C5
Chlorine Stack Gas Emissions					
Method 5					
Chlorine (lb/hr)	13.0	0.2	4.1	4.8	10.4
Total Chlorine (ppmv)	1215	21	405	441	871
Method 26					
HCl (lb/hr)	1.4	0.5	1.5	2.5	2.0
Cl ₂ (lb/hr)	16.2	0.2	2.0	3.5	8.4
Total Chlorine (lb/hr)	17.5	0.6	3.5	6.0	10.4
HCl (ppmv)	129	44	149	227	165
Cl ₂ (ppmv)	755	8	99	161	354
Total Chlorine (ppmv)	1639	59	347	549	873
Method Difference (%)	25.8	63.9	-16.8	19.7	0.2
Chlorine Feedrate (lb/hr)	461	35	359	490	651

Method 5: 0.1 N NaOH solution in impingers

Measurements made at on-site incinerator Source ID No. 906

TABLE 10-3. CEMENT KILN TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss		CI MTECs (µg/dscm)				SRE %	Summary Comments	Cond Date
		Actual Stack (ppmv)	ND (%)	Other	HW	S/HW (%)	ND (%)			
Part 1. Long non in-line raw mill kilns burning hazardous waste										
320C3	FF	86		4.70E+04	3.23E+05			65.71	1 run	8/1/95
320C1	FF	5.7		1.01E+05	3.34E+05			98.07		8/1/92
319C8	ESP	37			4.00E+05			86.49		12/1/90
208C1	ESP	4.6		8.51E+04	4.50E+05		27	98.74		1/1/93
335C1	ESP	122		5.77E+04	4.60E+05			65.27		6/1/92
305C3	ESP	29		7.68E+04	4.75E+05			92.36		8/20/92
323C9	ESP	35		7.04E+04	4.99E+05			90.99		6/1/96
205C1	ESP	17	1	2.32E+04	5.43E+05		8	95.69		8/1/92
323B2	ESP	63		3.13E+04	6.54E+05			86.43		6/1/96
203C5	ESP	131	2	1.87E+06	6.55E+05			92.32		8/16/96
318C1	ESP	47			6.86E+05	100		89.88	2 runs	5/24/93
207C1	MC/ESP	4.6		2.24E+05	7.20E+05		18	99.28		1/1/93
319C6	ESP	221			8.22E+05			60.44		12/1/90
205C5	ESP	25			8.62E+05			95.72		9/15/95
206C5	ESP	35			8.83E+05			94.15		9/15/95
319C2	ESP	27	1		9.18E+05			95.69		5/5/92
473C3	ESP	25			9.70E+05			96.15		5/8/95
206C1	ESP	81		3.11E+04	9.81E+05		6	88.18		8/1/92
300C7	ESP	17			1.01E+06			97.55		5/1/87
305C1	ESP	157		1.30E+05	1.25E+06			83.22		3/1/93
204C9	ESP	32		3.70E+05	1.35E+06	38		97.30	0.4	9/13/96
203C1	ESP	121	0.2	1.34E+02	1.36E+06			86.97		8/19/93
304C2	ESP	0.4	1		1.43E+06			99.96		8/1/92
319C4	ESP	51	0.3		1.48E+06			94.94		5/5/92
204C2	ESP	0.1	100	9.96E+04	1.62E+06			99.99		7/1/92
403C1	ESP	0.7	0.3	2.17E+05	1.62E+06		21	99.95		10/1/92
404C1	ESP	77		2.21E+05	1.65E+06		22	93.97		11/1/92
401C5	ESP	10		2.41E+05	1.82E+06	31	21	99.26		3/1/94
200C4	FF	34		1.20E+05	2.03E+06	75		97.68		8/1/95
202C8	FF	152		1.05E+06	2.08E+06			92.88		12/1/96
404C2	ESP	57		2.60E+05	2.09E+06	23	21	96.44		11/1/92

TABLE 10-3. CEMENT KILN TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss		CI MTECs (µg/dscm)				SRE %	Summary Comments	Cond Date
		Actual Stack (ppmv)	ND (%)	Other	HW	S/HW (%)	ND (%)			
404C4	ESP	60		4.02E+04	2.10E+06		16	95.90		1/17/95
319D6	ESP	49			2.13E+06			96.63		9/1/96
403C2	ESP	0.9		2.52E+05	2.13E+06	27	21	99.95		10/1/92
300C1	ESP	33		2.66E+04	2.16E+06			97.76		8/20/92
491C1	ESP	2.0		2.74E+04	2.16E+06			99.87		8/15/95
403C3	ESP	56			2.34E+06	100		96.47		11/1/94
302C1	ESP	12		1.93E+05	2.53E+06			99.35		8/1/92
402C4	ESP	20		5.38E+05	2.65E+06	69		99.06		4/4/94
402C1	ESP	22	0.2	3.17E+05	2.78E+06		12	98.97		3/27/92
228C2	ESP	195		4.27E+05	2.93E+06		5	91.48		5/1/92
201C1	FF	16		7.30E+03	2.94E+06	1	2.4	99.18		8/21/92
322C1	ESP	23		7.68E+04	2.98E+06			98.91		8/1/92
322C8	ESP	41		1.01E+05	3.01E+06			98.05		11/1/95
200C1	FF	14		8.07E+03	3.19E+06	1	6.4	99.35		8/21/92
200C5	FF	8.1		1.31E+05	3.45E+06	82		99.67		8/1/95
323B3	ESP	31		1.14E+05	3.65E+06			98.79		11/1/95
401C1	ESP	36	0.2	5.61E+05	3.67E+06			98.74		4/9/92
323C1	ESP	75		3.77E+04	3.72E+06		2	97.06		8/1/92
302C3	ESP	54		2.80E+05	4.42E+06			98.30		8/1/95
205C8	ESP	6.0							Nor	8/9/95
201C2	FF	6.5								1/30/91
208C3	ESP	7.3								1/1/97
300C6	ESP	8.3							B	5/1/87
204C7	ESP	8.8								7/18/94
472C2	ESP	9.4							1 run	5/1/91
204C8	ESP	10							1 run	7/18/94
204C6	ESP	11								7/18/94
305B3	ESP	15								10/7/96
207C3	MC/ESP	16								1/1/97
472C1	ESP	18							2 runs	5/1/91
319B4	ESP	20							2 runs	8/20/93
203C4	ESP	20								12/1/93
204B2	ESP	25								9/13/96

TABLE 10-3. CEMENT KILN TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss		CI MTECs (µg/dscm)				SRE %	Summary Comments	Cond Date
		Actual Stack (ppmv)	ND (%)	Other	HW	S/HW (%)	ND (%)			
319B3	ESP	27							1 run	8/23/93
320C5	FF	33							Nor	1/17/95
322C7	ESP	34								8/9/93
203C2	ESP	36								5/24/94
335C7	ESP	36							B	1/1/86
204B3	ESP	38								9/13/96
319B5	ESP	40							2 runs	8/23/93
319C7	ESP	42							B, 2 runs	12/1/90
322C4	ESP	46							B, 2 runs	8/9/93
322C6	ESP	49								8/9/93
335C8	ESP	50								1/1/86
322C5	ESP	53							Nor	8/9/93
206C7	ESP	55							Nor	8/9/95
681C2	FF	61								6/5/91
335B2	ESP	76								10/7/96
204C5	ESP	85							Nor	7/8/94
323B1	ESP	86							B	6/1/96
681C1	FF	88	1							11/10/93
319B6	ESP	88							B, 2 runs	8/23/93
335C6	ESP	100							Nor	7/8/93
228C7	ESP	117								10/1/88
228C6	ESP	135								10/1/88
680C1	FF	136								11/11/93

Part 2. Short and/or in-line raw mill kilns

202C1	FF	1.7	46	7.53E+05	3.00E+05	99.77	ILRM (on)	10/1/92
202C2	FF	31	1	1.13E+06	8.54E+05	97.69	ILRM (off)	10/1/92
303C1	QC/FF	1.9					Short, Nor, ILRM (off), CMBM	1/1/93
303C6	QC/FF	5.2					Short, ILRM (on), B, CMBM	9/1/92
303C2	QC/FF	10			1.31E+06	98.92	Short, ILRM (on), CMBM	1/1/93
303C7	QC/FF	82			1.01E+06	88.04	Short, ILRM, CMBM	12/1/95

TABLE 10-3. CEMENT KILN TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss		CI MTECs (µg/dscm)				SRE %	Summary Comments	Cond Date
		Actual Stack (ppmv)	ND (%)	Other	HW	S/HW (%)	ND (%)			
321C5	ESP	0.2			2.80E+05			99.50	Short, ILRM (on), BPM	8/1/95
321C4	ESP	0.6	49						Short, Nor, ILRM (on), BPM	10/13/93
321C5	ESP	0.9			2.80E+05			99.50	Short, ILRM (on)	8/1/95
321C1	ESP	0.9			9.55E+05			98.70	Short, ILRM (on), BPM	8/1/92
321C2	ESP	1.2							Short, Nor, ILRM (on), BPM	4/8/94
321C4	ESP	1.3	7						Short, Nor, ILRM (on)	10/13/93
321C2	ESP	1.3							Short, Nor, ILRM (on)	4/8/94
321C3	ESP	3.1							Short, B, ILRM (off)	10/13/93
321C3	ESP	4.5							Short, B, ILRM (off), BPM	10/13/93
321C1	ESP	6.8			9.55E+05			98.70	Short, ILRM (on)	8/1/92

Part 3. No longer burning hazardous waste

406C5	ESP	0.2			6.83E+05			99.20	Short, NLBHW, 2 runs, BPM	11/1/90
406C7	ESP	0.4			6.73E+05			97.80	Short, NLBHW, 1 run, BPM	11/1/90
301C1	FF	0.5		2.69E+05	1.40E+06	81	2.8	98.95	Short, NLBHW, ILRM (on)	5/1/93
315C2	FF	0.6	42		3.48E+05			98.30	Short, NLBHW, ILRM (on), BPM	7/15/92
315C1	FF	0.9	26		4.23E+05			98.96	Short, NLBHW, ILRM (on), BPM	7/15/92
309C6	MC/ESP	1.0		2.40E+05	8.50E+05			99.86	NLBHW	7/1/96
315C1	FF	1.4	2		4.23E+05			98.96	Short, NLBHW, ILRM (on)	7/15/92
317C1	FF	2.7	1	1.45E+04	1.21E+05	88		97.05	Short, NLBHW, ILRM (on)	1/22/93
315C2	FF	2.8	1		3.48E+05			98.30	Short, NLBHW, ILRM (on)	7/15/92
405C1	ESP	2.8	14		1.64E+06			99.75	Short, NLBHW, CMBM	8/1/92
306C1	MC/FF	3.1	6		8.90E+05			99.49	NLBHW	5/1/93
406C5	ESP	3.5			6.83E+05			99.25	Short, NLBHW, 2 runs	11/1/90
317C2	FF	3.7	1	1.44E+04	2.59E+05	94		98.00	Short, NLBHW, ILRM (on)	1/22/93
406C50	ESP	5			6.00E+05			98.90	Short, NLBHW, CMBM	8/1/92
308C1	ESP	5.0			8.06E+05			99.09	NLBHW	8/21/92
309C6	MC/ESP	9.0		2.40E+05	8.50E+05			98.78	NLBHW	7/1/96
301C1	FF	9.4		2.69E+05	1.40E+06	81	2.8	98.95	Short, NLBHW, ILRM (on), BPM	5/1/93
406C7	ESP	10			6.73E+05			97.73	Short, NLBHW, 2 runs	11/1/90
406C4	ESP	15		3.64E+05	1.74E+06	79		98.97	Short, NLBHW, CMBM	8/1/95
316C2	FF	22			4.51E+05			92.92	Short, NLBHW, CMBM	3/25/92

TABLE 10-3. CEMENT KILN TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss		CI MTECs (µg/dscm)				SRE %	Summary Comments	Cond Date
		Actual Stack (ppmv)	ND (%)	Other	HW	S/HW (%)	ND (%)			
316C1	FF	35			7.07E+05			92.75	Short, NLBHW, CMBM	3/25/92
309C1	MC/ESP	37	0.4		1.08E+06			94.93	NLBHW	10/1/92
309C2	MC/ESP	58	0.2		1.01E+06			91.53	NLBHW	10/1/92
406C1	ESP	80	0.2		1.00E+06		52	88.17	Short, NLBHW, CMBM	8/1/92
406C6	ESP	0.3							Short, NLBHW, B, 1 run, BPM	11/1/90
315C6	FF	1.6							Short, NLBHW, B, ILRM (off)	4/16/91
406C6	ESP	1.8							Short, NLBHW, B, 1 run	11/1/90
469C1	ESP	2.1							NLBHW	1/31/90
315C5	FF	2.6							Short, NLBHW, ILRM (on)	4/16/91
315C4	FF	3.0							Short, NLBHW, ILRM (on)	4/16/91
315C6	FF	3.6							Short, NLBHW, B, ILRM (off), BPM	4/16/91
406B4	ESP	5.1							Short, NLBHW	8/1/92
315C4	FF	5.3							Short, NLBHW, ILRM (on), BPM	4/16/91
315C7	FF	6.1							Short, NLBHW, ILRM (on), BPM	4/16/91
315C5	FF	6.4							Short, NLBHW, ILRM (on), BPM	4/16/91
317C3	FF	6.8	1						Short, NLBHW, B, ILRM (on)	1/22/93
316C3	FF	15							Short, NLBHW, Nor, CMBM	10/7/94
406B1	ESP	34							Short, NLBHW, CMBM	8/1/87
315C7	FF	37							Short, NLBHW, ILRM	4/16/91
406C8	ESP	38							Short, NLBHW	4/25/88
406C9	ESP	44							Short, NLBHW	8/1/87
406B2	ESP	57							Short, NLBHW, 1 run, CMBM	8/1/87

TABLE 10-4. CHLORINE EMISSIONS FROM LOW ALKALI CEMENT
KILNS (LAFARGE ALPENA, MI)

Kiln No.	Date	Testing Type	Total Chlorine ppmv @ 7% O ₂	Chlorine SRE %
23	Jun-92	CoC	6	99
22	Mar-94	Air Permit	5	
23	Apr-94	Air Permit	3	
23	Aug-94	Air Permit	13	
22	Jan-95	RCoC	34	
22	May-95	RoC	83	61

TABLE 10-5. LWAK TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss		CI MTECs (µg/dscm)				SRE (%)	Summary Comments	Cond Date
		Stack (ppmv)	ND (%)	Other	HW	S/HW (%)	ND (%)			
Part 1. Burning hazardous waste										
224C2	FF	216		1.30E+05	2.4E+05			11		8/1/96
310C2	FF	473		4.54E+05	4.8E+05			24		8/16/95
310C1	FF	1198		1.36E+05	7.6E+05		26	-100	Feedrate likely low Dry scrubbing?	8/12/92
224C1	FF	30		2.55E+03	8.5E+05		1	95		8/1/93
311C1	FF	1247		1.70E+05	9.0E+05		28	-75		8/8/92
475C1	FF	765		2.42E+05	1.2E+06		6	18		6/23/93
474C1	FF	954		2.12E+05	1.4E+06			10		9/1/94
336C2	FF	1050		3.85E+05	1.4E+06	73		11		3/24/94
336C1	FF	960		4.57E+05	1.4E+06			23		3/24/94
608C1	FF	917		9.76E+05	1.4E+06			43		3/1/96
225C2	FF	790		2.60E+05	1.5E+06			32		8/1/96
314C3	FF	1227		3.89E+05	1.5E+06	78		2		3/18/96
314C1	FF	851		1.70E+05	1.6E+06		18	26		8/8/92
226C2	FF	808		7.98E+04	1.9E+06			39		8/26/97
225C1	FF	1500		3.97E+03	2.0E+06		0.2	-10		8/1/93
312C1	FF	1230		1.55E+05	2.0E+06		14	16		8/8/92
313C1	FF	1531		1.43E+05	2.1E+06		12	-3		8/8/92
476C1	FF	1619		1.57E+05	2.1E+06	91		-6		2/1/93
223C1	FF	2080		1.17E+04	2.4E+06			-30		8/1/93
226C1	FF	2341		2.00E+04	3.2E+06	75		-8		7/1/93
307C1	FF/VS	41			3.4E+06			98	Wet scrubbing	12/1/92
307C3	FF/VS	14			7.8E+06	27		99.7	Wet scrubbing	12/1/92
307C4	FF/VS	32			1.2E+07	38		99.6	Wet scrubbing	12/1/92
307C2	FF/VS	26			1.4E+07	47		99.7	Wet scrubbing	12/1/92
479C2	MC/HE/FF/VS/DM	4			NA				B, wet scrubbing	8/1/90
479C1	MC/HE/FF/VS/DM	4			NA				Nor, Pre-BIF, wet scrubbin	8/1/90
312C2	FF	525			NA					5/1/95
223C2	FF	553			NA					1/14/97
Part 2. No longer burning hazardous waste										
227C1	FF	1330		4.65E+05	6.7E+05			-75	NLBHW	1/1/94

TABLE 10-5. LWAK TOTAL CHLORINE

EPA Cond ID	APCS	TCI Emiss		CI MTECs (µg/dscm)				SRE (%)	Summary Comments	Cond Date
		Stack (ppmv)	ND (%)	Other	HW	S/HW (%)	ND (%)			

Part 3. Dry Scrubbing Research Testing

226C51	DS/FF	86						90	SR 3:1	7/1/97
226C52	DS/FF	138						76	SR 2:1	7/1/97
226C53	DS/FF	16						98	SR 4:1	7/1/97

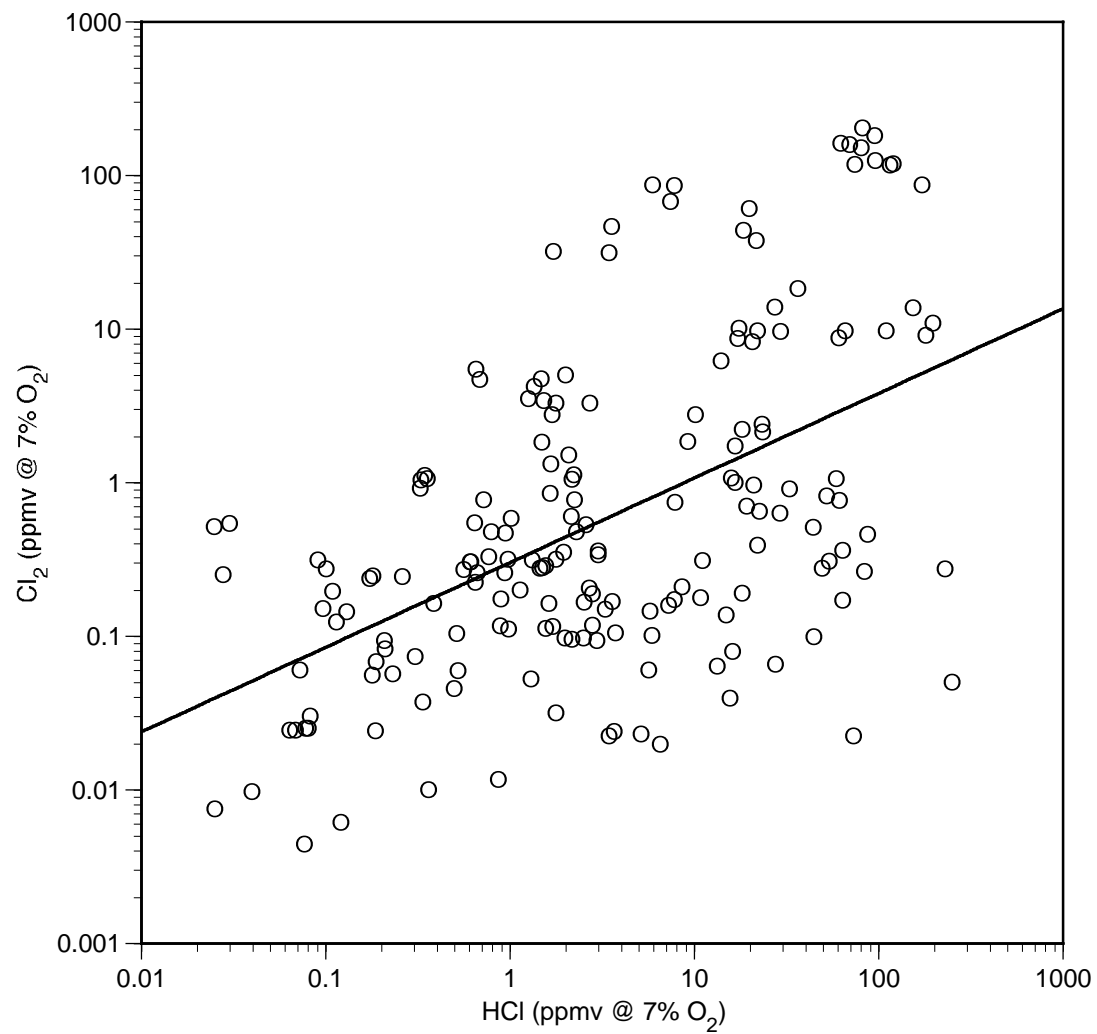


Figure 10-1. Simultaneous HCl and chlorine gas emissions from HW incinerators.

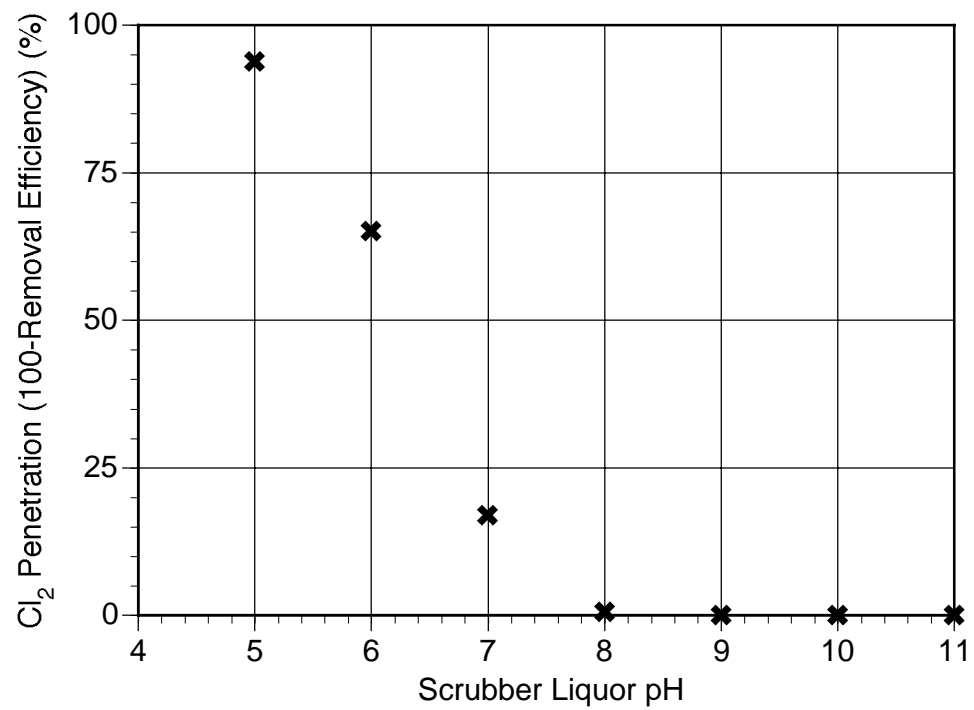


Figure 10-2. Chlorine gas capture performance of Monsanto "DynaWave" Reverse Jet and Froth Scrubber. (Source: S. Meyer and J. Myers, "Bromine and Chlorine Scrubbing With Lime Using Froth Technology," *Proceedings of the 1995 Incineration Conference*, Bellevue, WA, pp. 97-100, May 1995).

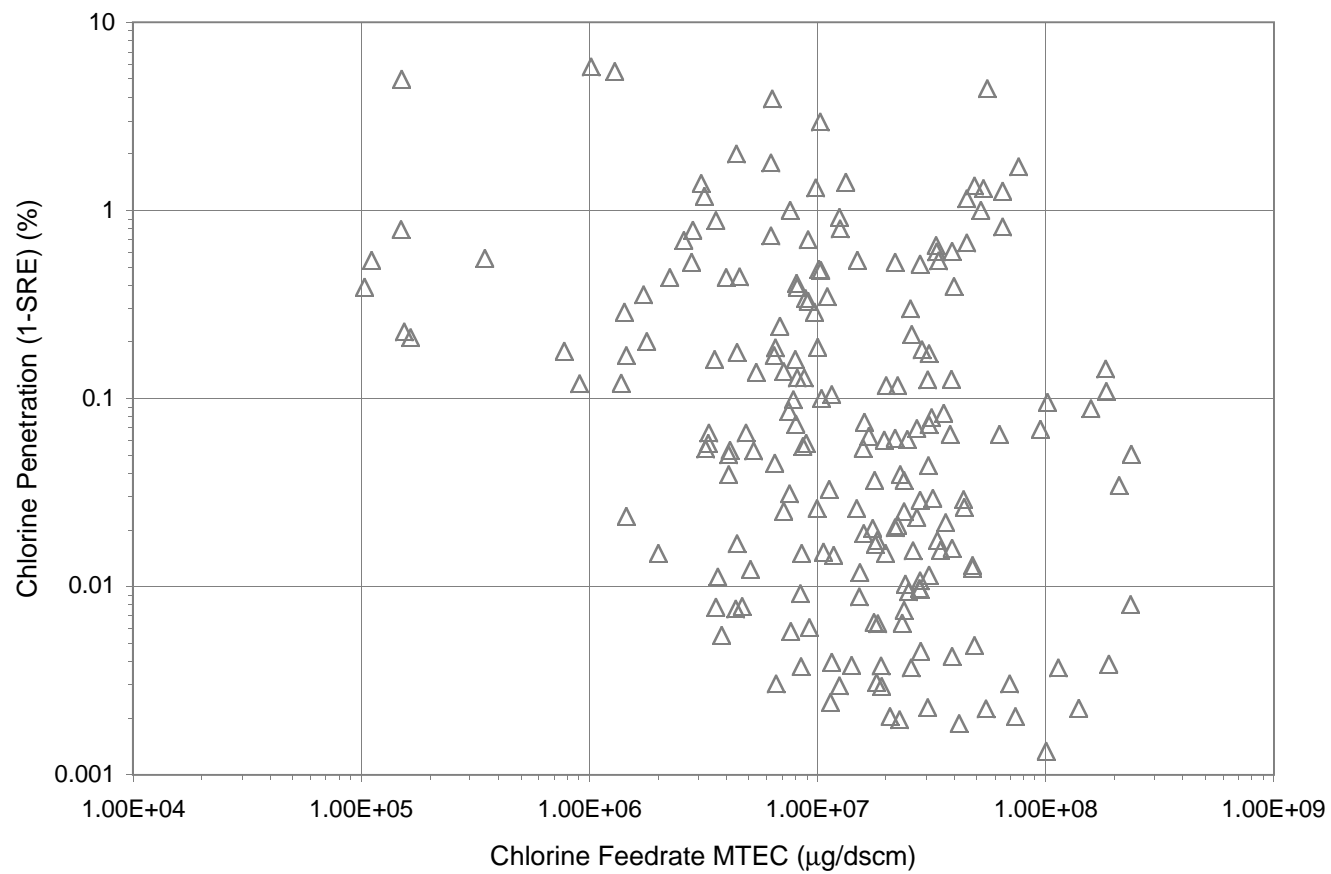


Figure 10-3. Chlorine control performance for incinerators using wet scrubbing.

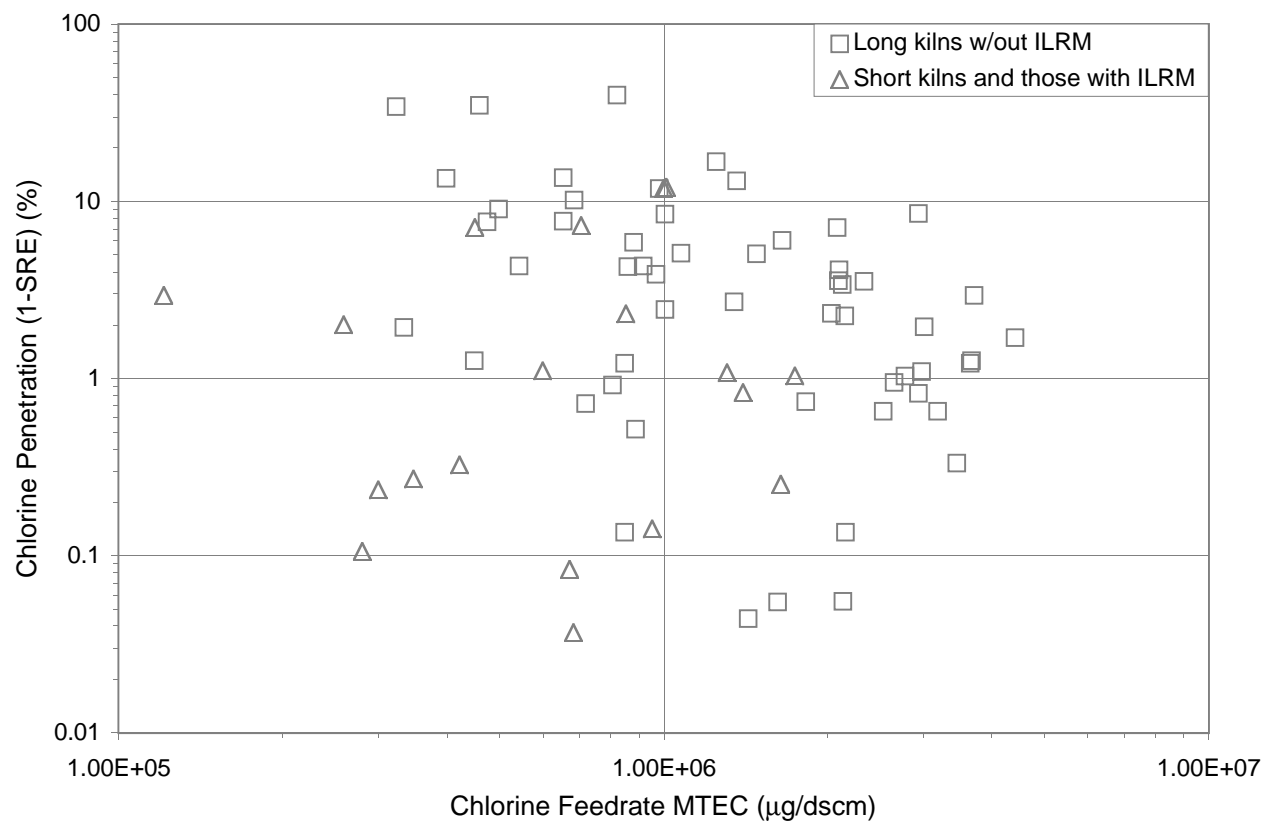


Figure 10-4. Chlorine control in cement kilns.

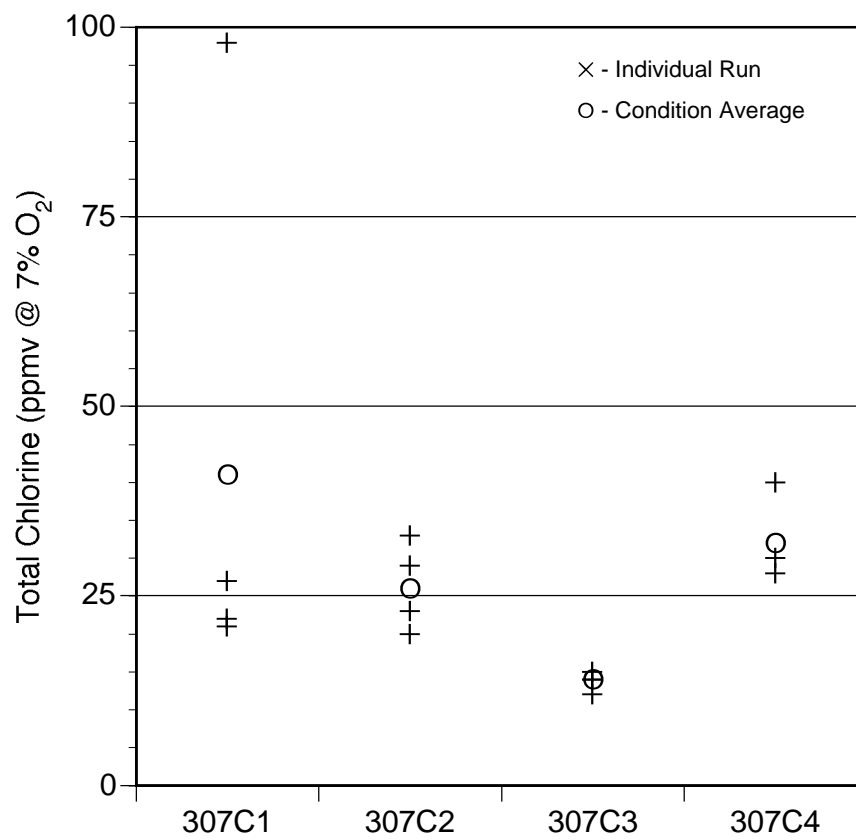


Figure 10-5. Total chlorine emissions from LWAK with wet scrubber (ID No. 307).